YUKON RIVER SONAR PROJECT REPORT

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by

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and

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ABSTRACT

The Yukon River sonar project has provided daily passage estimates of chinook salmon *Oncorhynchus tshawytscha*, and summer and fall chum salmon *O. keta* for most years since 1986. During this time, the project has undergone important changes including a frequency switch from 420 kHz to 120 kHz and a change from an aspect transducer aim to one which maximizes fish detection. Fish passage for each species was estimated through a two component process: (1) estimation of total fish passage with 120 kHz single-beam sonar, and (2) estimation of species proportions by sampling with gillnets of seven different mesh sizes. An estimated 2,685,357 ± 28,458 (s.e.) fish passed through the sonar sampling area between 6 June and 31 August 1997, 30% along the right bank and 70% along the left bank. Included were an estimated 133,691 ± 13,439 large chinook salmon (>700 mm long), 90,399 ± 15,765 small chinook salmon (<700 mm), 1,411,233 ± 30,213 summer chum salmon, and 623,367 ± 15,471 fall chum salmon. No passage estimates were obtained on the left bank from 26 June through 3 July nor on the right bank from 29 to 30 June due to a combination of factors including a heavy debris load, a strong band of noise in the left bank nearshore region, and a loss of signal. Passage estimates and standard errors do not account for this missed sampling time.

KEY WORDS: salmon, sonar, hydroacoustic, Yukon River, escapement, species apportionment, net selectivity, dual beam

INTRODUCTION

Commercial and subsistence fisheries harvest salmon *Oncorhynchus spp.* over more than 1,600 km of the Yukon River in Alaska and Canada. These salmon fisheries are critical to the lifestyle and economy of people in dozens of communities along the river, in many instances providing the largest single source of food and/or income to local residents. Management of these fisheries is complex and difficult due to the number, diversity, and geographic range of fish stocks and user groups.

Information upon which to base management decisions comes from several sources, each of which has unique strengths and weaknesses. Assessment of spawning salmon abundance in tributaries obtained through aerial surveys, mark-recapture, weirs, towers, or sonar techniques provide stock-specific estimates or indices of escapement. However, most of this information is obtained after the majority of the fisheries have been conducted. Gillnet test fisheries near the river mouth provide in-season indices of run-strength, but interpretation of these data is confounded by gillnet selectivity, changes in net site characteristics, and varying fish migration routes through the multi-channel river mouth. Also, the functional relationship between test-fishery catches and abundance is unknown.

Hydroacoustic (sonar) estimates of fish passage from this project complement information obtained from other sources. The project uses single-beam sonar to estimate daily upstream passage of fish. Gillnets of up to seven different mesh sizes are drifted to apportion the passage estimates to species, including chinook *Oncorhynchus tshawytscha*, and chum salmon *O. keta*. The project is located at river km 197 near Pilot Station, far enough upriver to avoid the wide, multiple channels of the Yukon River delta. Because salmon migrate from the river mouth to the sonar site in two to three days, the project provides timely information to managers of fisheries downstream of the sonar site. There is only one major spawning tributary (the Andreafsky River) downstream from the sonar site.

The Yukon River sonar project has provided fisheries management daily passage estimates for most years since 1986. The main challenges faced by the project have been to use sonar technology to detect and count as large a proportion of migrating fish as possible and develop viable methods for estimating the relative abundance of each species detected. Major progress has been made in several areas. The project has used hydroacoustic equipment since 1993 that operates at a lower frequency (120 kHz) than formerly (420 kHz), and is capable of detecting fish at longer ranges. In addition, species apportionment methodology has been streamlined, and net selectivity has been estimated more accurately (Mesiar et al. 1991, Fleischman et al. 1992, 1993, 1995). Project objectives in 1997 were to provide daily and seasonal passage estimates for chinook and chum salmon; estimate the precision of these estimates; and periodically carry out a routine system analysis to ensure accurate data collection and provide early detection of problems which might arise.

METHODS

Hydroacoustic Data Acquisition

Equipment

Sonar equipment for the right bank (relative to a downstream perspective) of the Yukon River included: 1) a Biosonics[1] Model 101 (SN 83-036) 120/420 kHz echosounder configured to transmit and receive at 120 kHz; 2) an International Transducer Co. (I.T.C.) Model 5398 120 kHz transducer (SN 003) configured for dual-beam use as Case II (3.6°x9.2° narrow, 12.3°x22° wide elliptical beams); 3) two 304.8 m (1,000 ft) Carol Model 1302 microphone conductor cables (SN's 201 and 202) connecting sounder to transducer; 4) a Hydroacoustic Technology, Inc. (H.T.I.) Model 403 chart recorder interface coupled with a Panasonic KXP 2624 dot matrix printer; and 5) a Hewlett-Packard Model 54501A digital storage oscilloscope (DSO).

Left-bank sonar equipment included: 1) a Biosonics Model 101 (SN 83-039) 120/420 kHz echosounder configured to operate at 120 kHz; 2) an I.T.C. Model 5398 120 kHz transducer (SN 005) configured for dual-beam use, Case I (2.1°x4.9° narrow, 3.8°x9.7° wide elliptical beam) for left-bank offshore; an I.T.C. Model 5398 120 kHz transducer (SN 004) configured for dual-beam use, Case I (2.0°x4.6° narrow, 3.9°x9.2° wide elliptical beam) for left-bank nearshore; 3) four 304.8 m (1,000 ft) Belden Model 8412 microphone conductor cables (SN's 501, 502 for left bank nearshore; and 503, and 504 for left bank offshore) connecting sounder to transducers; 4) an H.T.I. Model 401 chart recorder interface coupled with a Panasonic KXP1624 dot matrix printer; and 5) a Hewlett-Packard Model 54501A DSO.

All sonar systems were calibrated in April and May, 1997 (Table 1). Dual-beam data were digitized, processed, and electronically stored with a Biosonics Model 281 echo signal processor installed in a Compaq 386 20e personal computer.

Transducers were mounted on metal tripods and remotely aimed with Remote Ocean Systems (ROS) PT-25 dual-axis rotators. Rotator movements were controlled with a ROS PTC-1 controller with position feedback to the nearest 0.1°. Gasoline generators (650 W to 3500 W) supplied 110 VAC power.

Sampling Procedures

[1] Mention of a company's name does not constitute endorsement.

We deployed two transducers on the left (south) bank and a single transducer on the right bank at a point where the river was 1,030 m wide (Figure 1). The right bank has a stable, rocky bottom that drops off steeply to the thalweg (Figure 2). We positioned the right-bank transducer in 1.5 m of water roughly 8 m from shore and aimed along the bottom, sampling a single stratum to a range of 90-120 m. The left-bank river bottom drops off gradually, with a slightly steeper slope nearshore than offshore (Figure 3). This bottom profile required the deployment of two transducers to ensonify the entire fish migration corridor. One transducer was deployed within 10 m of shore to sample both a nearshore stratum (0-70 m) with a low aim and a midshore stratum (70-250 m) with a slightly higher aim. A second transducer was deployed 60-100 m offshore from the first transducer, creating a third stratum and extending the sampling range on the left bank to a maximum of 300-350 m. To avoid losing the offshore transducer in the silty river bottom, we raised it to the surface, carefully returned it to the river bottom, and reaimed it every other day. All transducers were repositioned frequently to compensate for the dynamic water level.

Each acoustic sampling stratum was subdivided into five equal range sectors. Sample data were tallied by sector in 15-minute intervals during daily sampling periods from 0530 to 0830, 1330 to 1630, and 2130 to 0030. The single right-bank stratum was sampled continuously during all sampling periods. Sampling on the left-bank alternated every 1/2-hour between the three left-bank strata in the following sequence: nearshore, midshore, offshore, midshore, nearshore, and offshore. Sampling in this manner reduced the amount of sampling time lost during reaiming.

We counted echoes as fish if at least one ping in the cluster passed the second threshold level (threshold levels documented below), and the targets did not resemble inert downstream objects. Multiple fish tracings were marked if there was a discontinuity in the tracing, and the second mark indicated movement in a direction different from the first. Fish tracings were tallied on field data forms, then entered into an R:Base database. The data were checked daily for errors in data entry or tallying, then processed using commercial statistical data processing (SAS) software.

For consistency, all personnel were trained early in the season to distinguish between fish tracings and non-target echoes. Chart printouts were reviewed daily by either the project leader, crew leader, or a trained technician to check the accuracy of the counting personnel in defining fish tracings, reducing biases that might develop from individual differences in marking. The quality of the chart image was checked for indications of signal problems, changes in bottom conditions, or aiming problems.

Twenty-four hour continuous sampling sessions were scheduled four times (19 June, 14 July, 29 July, and 19 August) to estimate uncertainty associated with the normal sampling schedule, and to satisfy requests from the public. On the right bank, the single stratum was sampled continuously with counts recorded at 15-minute intervals. Left-bank sampling was divided among the three strata in proportions consistent with the regular sampling schedule.

Equipment Settings, Thresholds

We used a 40 log(R) time-varied gain (TVG), 5 kHz bandwidth, and 0.4 ms transmit pulse duration (except as noted) during all sampling activities. Transmit intervals (pulse repetition rates) were chosen to maximize the clarity of the tracings without overloading printer buffers; most strata transmit intervals were set at 0.4 s.

Four printer thresholds in 3 dB increments in signal amplitude, corresponding to degrees of gray-line, were set for all strata. Right-bank thresholds (-44, -41, -38, and -28 dB), left-bank nearshore and midshore thresholds (-45, -42, -39, -37 dB), and left-bank offshore thresholds (-44, -41, -38, and -36 dB) were set low enough to detect salmon-sized targets and high enough to eliminate unwanted background noise. The fourth right-bank threshold was set higher in an attempt to increase the visibility of fish tracings found within prominent bottom markings by reducing the amount of bottom signal passing this fourth threshold; the constructive interference of bottom reflections and target echoes amplified signals above this fourth level producing fish targets that might otherwise be masked. Left-bank echosounder transmission and gain settings were adjusted frequently during the season to compensate for signal loss due to environmental factors (Appendix A). Threshold levels (in mV) were recorded and converted to target strength, TS_{dB}, as follows:

$$TS_{dB} = 20 \bullet \log\left(\frac{T_{mV}}{1000}\right) - \left(SL + G_S + G_R\right) \tag{1}$$

where

T_{mV} = chart recorder threshold in mV,
SL = transmitted source level in dB,
G_S = through-system gain,
G_R = receiver gain.

Aiming

The aiming strategy was to maximize fish detection. This same strategy was implemented in the past two years (Maxwell et al, 1997; Maxwell and Huttunen, 1998). Horizontally, the beam was oriented roughly perpendicular to fish movement so the majority of fish would present the largest possible echo amplitude. Since most fish travel close to the river bottom, each transducer beam was aimed vertically to produce the best bottom signals throughout the range (in effect skimming the beam along the bottom).

The rapidly and continually fluctuating water level required us to reposition, then carefully re-aim the transducers frequently. The left-bank transducers were re-aimed more often to compensate for the dynamic bottom conditions on that side of the river. Rotator settings for each new aim were documented and chart printouts of the new aim were marked and dated. Because returning to the same rotator settings did not guarantee a return to exactly the same aim, all personnel were trained to first reset pan and tilt settings, then carefully match bottom striations on the current chart printout with those of the marked charts when changing between sampling strata.

System Analyses

The hydroacoustic system was routinely analyzed following procedures first established in 1995 (Maxwell et al, 1997). System analyses included a combination of equipment performance checks, bottom profiles using both down-looking and side-scanning sonars, and hydrologic measurements.

Hydroacoustic Equipment Checks

The hydroacoustic equipment was professionally calibrated prior to the field season and both echosounders were physically examined, functionally checked, and comprehensive transmitter, receiver, and gain measurements were made. We measured the transmitter output through a 50 ohm load five times during the field season and compared our results to those obtained in pre-season laboratory calibrations. Weekly, we checked the time-varied gain circuitry of both echosounders by measuring the voltage of internally generated calibration signals amplified by the 40 log (R) TVG circuitry at four ranges (25 m, 50 m, 100 m, and 250 m) using a DSO. We compared the measured voltages with calculated theoretical values and pre-season values.

To verify that the complete sonar system was operating normally, we estimated the target strength of a 4.5 kg, 10.2 cm diameter, lead downrigger weight (approximate salmon-size target) and a 38.1 mm stainless steel target from both DSO narrow beam peak voltage amplitude manual measurements and from measurements made by a Biosonics Model 281 dual-beam echo signal processor (ESP). The targets were suspended singly from the side of a skiff anchored offshore from the left bank. We aimed the beam at the suspended target, maximizing the echo amplitude in both the horizontal and vertical planes. During data collection, signals were filtered for bandwidth (5 kHz), and half-amplitude pulse width (0.36-0.52 ms). Target data were converted from the ESP software to an Access database and analyzed using database and Excel functions. During post-processing, the target data were first isolated from extraneous echoes by selecting echoes within a limited range bin, then filtered for noise-corrupted echoes using the following criteria: 1) the beam pattern factor ($2B\theta$) less than or equal to -12 dB; 2) the wide beam peak amplitude greater than or equal to the narrow beam peak amplitude; and 3) the quarter-amplitude pulse width greater than or equal to the half-amplitude pulse width for both narrow and wide beams. No target strength data were obtained from the right bank because of the difficult logistics involved in suspending a fixed target in the beam there.

We tested the accuracy of the print threshold levels by sending a TVG-amplified calibration tone through the digital chart recorder interface to the printer where signal amplitudes surpassing four incremental thresholds were displayed as different gray levels. Chart recording threshold location measurements were compared with corresponding time-dependent signal amplitude measurements on the DSO.

All transducer cables were tested for transmission loss prior to deployment and again at the end of the season. The cables were tested by transmitting a 1 VAC signal through the cable and through a 50 ohm load, and measuring the resulting voltage at the opposite end of the cable with a DSO. Initial measurements through the resistor load proved unreliable this season due to problems with the resistor plug. Final measurements were made without the added resistance.

Radio Telemetry

In past seasons, right-bank data were telemetered across the river and all tallying was performed on the left bank. This season, we encountered electronic noise problems that apparently attended replacement of the modem system with a data radio. This prevented us from using the radio telemetry equipment in 1997.

Bottom Profiles

Bottom profiles were recorded along both banks using a Lowrance X-15 fathometer to locate deployment sites with suitable linear bottom profiles. Inseason, the fathometer was used regularly to monitor changing bottom conditions and to watch for the formation of sand bars capable of re-routing fish to unensonified areas. We created a bathymetric map of the sampling area (Figure 4) during the season to document bottom conditions and sand bar formation.

Visual bottom images of the study area along both banks were recorded using an Imagenex Model 001 sidescanning sonar unit and digital audio tape (DAT) recorder. These data were recorded while motoring parallel to each shore in five minute segments and across the river between the two transducers.

Both the fathometer and sidescanning sonar unit were used for conducting bank-to-bank transects. The primary purpose of the transects was to monitor river bottom topography and look for fish in the unensonified regions of the river. Previously, bank-to-bank transect data were used to estimate the passage of fish beyond the range of the shore-based sonar (Mesiar et al 1991; Fleischman et al. 1992, 1993). Since the effective sampling ranges were extended by the conversion to 120 kHz center frequency (Fleischman et al. 1995), transects have not revealed significant numbers of fish beyond the sonar range. No estimates of offshore passage were made using transect data.

Hydrologic Measurements

Hydrologic measurements were recorded daily. Water level was measured using a staff gauge located offshore from the field camp. Reference measures were made four times from United States Geological Survey, Water Resources Division benchmarks located approximately 500 m downstream of Pilot Station. Daily staff gauge measurements were adjusted to that reference to compare water levels from previous years. Conductivity, air and water temperature, and secchi disk measurements were taken offshore along both banks.

Species Composition Data Acquisition

Equipment and Procedures

Gillnets were drifted in three zones (right bank, left-bank nearshore, and left-bank offshore) within the sonar sampling range to estimate species composition. Seven different mesh sizes were fished to effectively capture all size classes of fish present and detectable by the hydroacoustic equipment. During the summer season (prior to 19 July), gillnets of mesh sizes 216 mm (8.5 in), 43 meshes deep (MD); 191 mm (7.5 in), 48 MD; 165 mm (6.5 in), 55 MD; 127 mm (5 in), 72 MD; 102 mm (4 in), 90 MD; and 70 mm (2.75 in), 131 MD, were used. Large mesh gear, 216 mm (8.5 in) and 191 mm (7.5 in), was discontinued during the fall season (starting 19 July) and a 140 mm (5.5 in, 65 MD) mesh was added. All nets were 45.7 m (25 fathoms, 52.5 stretch fathoms) long and 7.6 m (25 ft) deep. Nets were constructed of Momoi MTC-50 or MT-50, shade 11 or 3, double knot multifilament nylon twine and hung using a 2:1 hanging ratio.

Gillnetting took place between sonar periods twice daily from 0915 to 1215 and 1715 to 2015. During each gillnet sampling period four nets were drifted within each of three zones, one on the right bank and two on the left bank, for a total of 24 drifts per day. The left-bank nearshore drift was very close to shore (shoreward end 5 to 10 m from shore). The left-bank offshore drift originated further offshore so as not to overlap with the nearshore drift (shoreward end 50 to 70 m from shore). All drifts with one net were completed before switching to the next net. The two left-bank drifts with a given net were not done consecutively (i.e., drifts were done on alternate banks: left-right-left), so that there was a minimum of 20 minutes between the drifts on the same bank.

Four times were recorded to the nearest second onto field data sheets for each drift: net start out (net starting out of boat, SO), net full out (FO), net start in (SI), and net full in (FI). Fishing time (t), in minutes, for each drift was approximated as

$$t = SI - FO + \frac{FO - SO}{2} + \frac{FI - SI}{2}. \qquad \textbf{(2)}$$

Drifts were generally eight minutes in duration but were shortened when necessary to avoid snags and limit catches during times of high fish passage.

Captured fish were identified to species and measured to the nearest 5 mm length. Salmon species were measured from mid-eye to fork of tail; non-salmon species were measured from snout to fork of tail. Fish species, length and sex were entered onto field data sheets. Each drift record included the date, fishing time, sampling period, mesh size, length of net, and captain's initials. Data were transferred from field data sheets into an R:Base database and processed using SAS software.

Captured fish were distributed to local villagers or sold to local processors whenever possible. Fish dispersal was documented daily.

Species Proportions

Species proportions were estimated from relative gillnet sampling catch-per-unit-effort (CPUE) data, after first adjusting for gillnet size-selectivity. Separate gillnet selectivity curves were used for chinook salmon, summer chum salmon, fall chum salmon, coho salmon (*O. kisutch*), pink salmon *(Oncorhynchus gorbuscha)*, whitefish *(Coregonus)*, cisco *(C. sardinella, C. laurettae)*, and a combined group of all other species. These gillnet selectivity curves and a summary of their development are presented in Maxwell et al. (1997).

Analytical Methods

Fish Passage

Daily fish passage was estimated by summing the counts over all sectors, converting this number to an hourly passage rate, averaging the passage rate from each sampling period, and expanding the final count temporally to obtain the daily estimate. Total daily passage was estimated separately for each zone. Zone 1 consisted of the entire counting range on the right bank, corresponding with stratum 1. Stratum 2 is reserved as a second right-bank stratum, which hasn't been used since 1994. Zone 2 consisted of the counting range from 0 m to 50-70 m (end range dependent upon the changing bottom profile) on the left bank, corresponding with stratum 3. Zone 3 consisted of the counting range from 50-70 m to 300-350 m (end range dependent upon the placement of the offshore transducer), corresponding with strata 4 and 5.

Total fish (y) passing through stratum s of zone z during sample q of sonar period p of day d was calculated by summing net upstream targets over all sectors c,

$$y_{dzpsq} = \sum_{c} y_{dzpsqc} . \tag{3}$$

The passage rate (r) in fish per hour, for stratum s of zone z during sonar period p of day d, was computed as:

$$r_{dzps} = \frac{\sum_{q} y_{dzpsq}}{\sum_{q} h_{dzpsq}} \tag{4}$$

where h_{dzpsq} is the duration, in hours, of sample q of sonar period p of day d for stratum s of zone z. The passage rate for zone z during sonar period p of day d was computed as the sum of passage rates for strata associated with each zone,

$$r_{dzp} = \sum_{s} r_{dzps} . \tag{5}$$

The passage rate for zone z during day d was estimated by the average sonar period passage rate,

$$\hat{r}_{dz} = \frac{\sum_{p} r_{dzp}}{n_{sdz}}, \tag{6}$$

where n_{Sdz} is the number of sonar periods during day d on zone z. Finally, the total passage of fish in zone z during day d was estimated as

$$\hat{y}_{dz} = 24\,\hat{r}_{dz} . \tag{7}$$

Sonar sampling periods, each three hours long, were obtained at regular (systematic) intervals of eight hours. Treating the systematically sampled sonar counts as a simple random sample would over-estimate the variance of the total, since sonar counts were highly autocorrelated (Wolter 1985). To accommodate these characteristics of the data, a variance estimator based on the squared differences of successive observations, recommended by Brannian (1986) and modified from Wolter (1985), was employed;

$$\hat{V}ar(\hat{y}_{dz}) = 24^2 \frac{1 - f_{dz}}{n_{Sdz}} \frac{\sum_{p=2}^{n_{Sdz}} (\hat{r}_{dzp} - \hat{r}_{dz,p-1})^2}{2(n_{Sdz} - 1)}, \tag{8}$$

where f_{dz} denotes the first-stage sampling fraction, 8 hrs/24 hrs = 0.33.

Missing Data

Equipment malfunctions and other uncontrollable events occasionally result in missing sonar data. When individual subsamples within a sonar period were missed, fish passage was estimated based on existing subsamples for that period. If a portion of a subsample was missed, fish passage was estimated from the remaining sample provided the sample contained at least five of the fifteen minutes. Data missing from a single stratum for an entire period or more was estimated from data obtained from period(s) sampled during the same day. No estimates were made of data missing from an entire day or more.

Species Composition

The catch (c) of species i and length l during drift j of mesh m during gillnet sampling period f in zone z on day d was first adjusted for gillnet selectivity (s) of species i and length l in mesh m. Adjusted catch (a) was calculated as

$$a_{ildzfmj} = \frac{c_{ildzfmj}}{s_{ilm}}, \tag{9}$$

if selectivity was at least 0.10. If selectivity was less than 0.10, adjusted catch was set to zero.

Total effort (e), in fathom-hours, of drift j with mesh size m during gillnet sampling period f in zone z on day d was calculated as

$$e_{dzfmj} = \frac{25 \bullet t_{dzfmj}}{60}, \tag{10}$$

since all nets were 45.7 m (25 fathoms) long. CPUE (C) for length l of species i in drifts of mesh m during gillnet sampling period f in zone z on day d was computed as the total adjusted catch divided by total effort,

$$C_{ildzfm} = \frac{\sum_j a_{ildzfmj}}{\sum_j e_{dzfmj}}. \tag{11}$$

The mean CPUE across meshes having non-zero CPUE was computed, i.e.,

$$C_{ildzf} = \frac{1}{n_{mildzf}} \sum_m C_{ildzfm}, \tag{12}$$

where n_{mildzf} is the number of meshes having adjusted catches of length l of species i greater than 0 during test-fish period f of day d in zone z. The total CPUE for species i was computed by summing over all lengths,

$$C_{idzf} = \sum_l C_{ildzf}. \tag{13}$$

The proportion (p) of species i during test-fishing period f in zone z on day d was then estimated by the ratio of the sum of the mean CPUE of all lengths of species i having non-zero CPUE to the total of the same quantity summed over all species, i.e.,

$$\hat{p}_{idzf} = \frac{C_{idzf}}{\sum_i C_{idzf}}. \tag{14}$$

For zone z on day d, the proportion of species i was estimated as

$$\hat{p}_{idz} = \frac{\sum_f C_{idzf}}{\sum_i \sum_f C_{idzf}}, \tag{15}$$

which is equivalent to the mean of the two test-fishing period proportions, weighted by the total CPUE for all species in each test-fishing period.

The estimator of the variance of p_{idz} was adapted from Cochran (1977:64), weighting each replicate by total (all species) CPUE:

$$\hat{V}ar(\hat{p}_{idz}) = \frac{1}{n_{Tdz}} \sum_{f=1}^{n_{Tdz}} \left(\frac{\sum_f \sum_l \sum_m C_{ildzfm}}{\frac{1}{n_{Tdz}} \sum_i \sum_f \sum_l \sum_m C_{ildzfm}} \right)^2 \frac{(\hat{p}_{idzf} - \hat{p}_{idz})^2}{n_{Tdz} - 1} \tag{16}$$

where:

n_{Tdz} = number of gillnet sampling periods in zone z during day d.

Fish Passage by Species

The passage of species i in zone z during day d was estimated by

$$\hat{y}_{idz} = \hat{y}_{dz} \bullet \hat{p}_{idz}. \tag{17}$$

Finally, passage estimates were summed over all zones and all days to obtain a seasonal estimate for species Y_i,

$$\hat{Y}_i = \sum_d \sum_z \hat{y}_{idz} \tag{18}$$

Except for the timing of sonar and gillnet sampling periods, sonar-derived estimates of total fish passage were independent of gillnet-derived estimates of species proportions. Therefore the variance of their product (daily species passage estimates y_{idz}) was estimated as the variance of the product of two independent random variables (Goodman, 1960),

$$\hat{V}ar\left(\hat{y}_{idz}\right)=\hat{y}_{dz}^{2}\hat{V}ar\left(\hat{p}_{idz}\right)+\hat{p}_{idz}^{2}\hat{V}ar\left(\hat{y}_{dz}\right)-\hat{V}ar\left(\hat{y}_{dz}\right)\hat{V}ar\left(\hat{p}_{idz}\right). \tag{19}$$

Finally, passage estimates (equation 18) are assumed independent between zones and among days. so the variance of their sum (equation 19) was estimated by the sum of their variances,

$$\hat{V}ar\left(\hat{Y}_{i}\right)=\sum_{d}\sum_{z}\hat{V}ar\left(\hat{y}_{idz}\right). \tag{20}$$

Assuming normally distributed errors, 90% confidence intervals were calculated as

$$\hat{Y}_{i}\pm 1.645\sqrt{\hat{V}ar(\hat{Y}_{i})}. \tag{21}$$

SAS program code (Appendix B) was used to calculate passage estimates and estimates of variance.

Missing Data

Equipment malfunctions and commercial fishery openings occasionally conflict with gillnet sampling objectives. When insufficient gillnet sampling data is available for a given day, the data are pooled with data from an adjacent day with adequate data, and the pooled data are then applied to the corresponding day(s) of sonar passage estimates lacking sufficient gillnet sampling data.

RESULTS

The Yukon River sonar project operated from 6 June through 31 August in 1997. Rapidly changing water levels during this time created a series of problems including diminished echo amplitudes, a large band of reverberation which initially masked target echoes in the left-bank nearshore range, and a large debris load. All three transducer pods were pulled from the water after the first sampling period 28 June because of heavy debris in the river (Figure 5) and redeployed on 1 July. Signal loss was at its highest level at redeployment, which prevented us from sampling on the left bank until 4 July and resulted in additional missed sonar periods or shortened ranges during high signal loss periods. The situation required us to frequently redeploy transducers, spend more time aiming to assure bottom beam orientation, and increase the frequency of system analyses. Despite the added challenges, available passage estimates were transmitted to fishery managers in Emmonak by 8:30 a.m. except when prevented by cummunication difficulties.

Test-Fishing

A total of 6,600 fish were captured during 1,988 drifts totaling 12,637 minutes. The catch included 3,350 summer chum salmon, 1,581 fall chum salmon, 242 chinook (700 mm length or greater), 227 "jacks" (chinook less than 700 mm in length), 488 coho salmon, 10 pink salmon, 267 whitefish, 295 cisco, and 140 other fish. Gillnet sampling was not conducted during commercial fishery openings to avoid disrupting commercial fishering activities. On four days with commercial openings (15, 18, 22 June and 8 August), we drifted all sizes of gillnets during a single sampling period. The remaining commercial fishery openings in the Y2 district (25 June and 11, 13, and 18 August) did not conflict with our sampling times. Gillnet sampling was not conducted on 28 or 29 June because of the heavy debris load in the river. Data from missed or partial gillnet sampling periods were pooled with those from an adjacent day to estimate species proportions.

Hydroacoustic Estimates

An estimated 2,685,357 ± 28,458 (s.e.) fish passed through the sonar beams during the 1997 field season; 798,162 ± 12,128 (30 %) along the right bank, 998,951 ± 17,525 (37 %) along the left bank nearshore, and 888,244 ± 18,859 (33 %) along the left bank midshore and offshore. Tables 2 and 3 provide daily records of passage estimates by zone, standard errors, and the total passage coefficients of variation. No attempt was made to estimate passage during missed sampling time caused by the heavy debris load and subsequent periods of high signal loss. The standard errors listed above do not account for this lost sampling time.

Passage estimates of target species included 224,090 chinook salmon and 2,034,600 chum salmon (Table 4). Chinook salmon were comprised of 133,691 ± 13,439 fish greater than 700 mm in length, and 90,399 ± 15,765 "jacks" shorter than 700 mm. Most (1,411,233 ± 30,213) of the chum salmon passed during the summer season from 6 June through 18 July; the remainder (623,367 ± 15,471) passed during the fall season from 19 July through 31 August. Passage estimates of non-target species included 153,502 ± 8,855 coho salmon, 3,282 ± 1,861 pink salmon, and 269,883 ± 14,273 non-salmon species. Daily passage estimates by species are listed in Tables 5 and 6 with totals and standard errors for the summer and fall seasons. Daily passage estimates for summer chum, fall chum, small chinook, large chinook, and coho salmon are plotted in Figure 6. The 25%, 50% and 75% passage dates are marked on the charts for chinook and chum salmon.

Chum salmon made up the largest proportion of fish caught in both the summer (Figure 7) and fall season (Figure 8). The majority of the chinook salmon passed the sonar site during June, with the last chinook salmon caught on 26 July. Following the first capture on 29 July, coho salmon catches increased steadily with the largest daily estimate recorded on 16 August, then alternately dropped off and increased during the remainder of the project's operating period. Coho salmon are not target species, and the sonar project is not designed to estimate coho salmon abundance. Pink salmon estimates were extremely low during the 1997 field season.

Comparisons of daily passage estimates with mean CPUE by zone and by season (summer and fall) reveal a significant relationship between these data sets (Figures 9 and 10). During the summer season, the right-bank zone and left-bank nearshore zone show a relatively high correlation between daily passage estimates and CPUE ($R=0.610$ and $R=0.634$; $p<0.001$). The left-bank offshore zone shows less similarity between the passage and gillnet CPUE ($R=0.518$; $p<0.01$). Fall season daily passage estimates and CPUE are significantly correlated ($p<0.001$) for all three zones (right bank $R=0.779$, left bank nearshore $R=0.597$, and left bank offshore $R=0.669$).

The percent of summer and fall passage was plotted in 20 m range increments by bank and by season to illustrate the horizontal distribution of fish in the sampling area (Figures 11 and 12). Passage levels declined sharply as a function of the distance offshore. During the summer and fall seasons, 90% of the detected passage on the left-bank occurred within 170 m of the left-bank nearshore transducer. On the right-bank, 90% of the detected passage occurred within 70 m of the right-bank transducer.

System Analyses

We estimated a total passage of 143,021 fish during four 24-hour sampling periods (Table 7). Data collected during the routine 9-hour sampling periods on these days resulted in estimates 12% greater at 162,498 fish. The largest difference between the two sampling schedules occurred on 19 June when 50,445 fish were estimated during the complete 24-hour sampling period, and 66,293 fish were estimated to have passed based on the 9-hour sample period data, an increase of 24%. On 29 July, estimates from the two methods were nearly identical.

Results from bank-to-bank down-looking transects are inconclusive. Few fish were detected during these transects. No offshore passage estimates were made using these transect data.

Bottom profiles conducted along the left and right banks at the transducer locations revealed smoothly sloping areas suitable for sonar deployment (Figures 2 and 3). No changes were noted in the steeply sloping, rocky bottom along the right bank during the field season. The sandy, gently sloping left-bank bottom remained smooth and linear throughout the season.

Fathometer data revealed the formation of two sand bars during the field season. Both bars were observed in 1995 and 1996 (Maxwell et al, 1997; Maxwell and Huttunen, 1998). The Atchuelinguk Bar (Figure 4) extended downstream along the right bank from the confluence of the Atchuelinguk and Yukon Rivers to slightly downstream of the First Slough entrance, 900 m upstream of the right-bank sampling region. The second bar, termed the River Bend sand bar, extended downstream from the river bend to just below the left-bank sampling area. We measured it's side-edge (Figure 3) approximately 500 m from the left-bank shoreline using a laser rangefinder. Both sand bars were closely monitored throughout the field season.

Water level fluctuated more dynamically this season than in previous years (Figure 13). According to verbal communication with St. Mary's residents, the water level was extremely low in early May. It rose rapidly and peaked prior to the start of the field season. The water level continued to oscillate producing additional peaks on 1 July and 18 August. Conductivity rose steadily until early August, then declined slowly (Figure 14). Right and left bank conductivity levels were more similar this year than in previous years (1997, R=0.94; 1996, R=0.88;1995, R=0.56). Measurements along both banks were nearly identical from 23 June through 9 July and 11 through 24 August, shortly before and after peak water levels. A comparison of water level and conductivity demonstrated an inverse relationship for both the right and left sides of the river ($R= -0.35$ and $R= -0.58$; $p<.001$). Secchi disk measurements (Figure 15) began high and ended low, with less correlation to water level ($R=0.24$; $p<0.03$). Daily water temperatures ranged from 13-19 °C and averaged 16.5 °C.

Transmitter output (Figure 16) and TVG plots (Figures 17 and 18) depict the uniform performance of both echosounders throughout the season. We began verifying the TVG on the wide-beam channel when on 8 August we noticed the left-bank echosounder's wide-beam gain was set at 10 dB. During previous standard target work, we had noticed a large off-axis component in the collected dual-beam data. We measured the wide-beam target data with the DSO and found that it differed from the narrow-beam channel by 10 dB. At the time, the echosounder's dial appeared to be set at 0. It was later found (8 August) that the dial was turned to its maximum gain of 10 dB. This gain affected two standard target dual-beam data files. We compensated for the gain in post-processing by adding 10 dB to the wide-beam receive sensitivity. Field measurements differed from pre-season laboratory values by less than 1 dB on wide and narrow beam channels for both transmitter output and TVG analyses.

Chart recorder print thresholds were tested regularly using calibration tones from the echosounder. The average difference between voltage levels printed on the chart recorder and similar measurements on a DSO was less than our ability to measure.

Pre-deployment signal loss through the six 312.5 m (1,000 foot) transducer cables averaged 2.0 ± 0.3 (s.e.) dB. Post-deployment signal loss averaged 2.4 ± 0.6 (s.e.) dB.

Documentation of a Reverberation Band

This field season, we encountered a strong band of reverberation in the left-bank nearshore zone and documented attendant range-dependent signal loss (Appendix A). At the start of the season, the area of reverberation encompassed the entire left-bank nearshore zone (0 to 50 m) and extended into the offshore zone an additional 20 to 30 m, with echo amplitudes passing our highest threshold level (-37 dB). Initially we were unable to detect fish tracings in and beyond the affected area. We documented the presence of the phenomenon with both side-looking and down-looking sonar equipment (Figures 19 and 20) and deployed a second transducer at the offshore edge of the band which enabled us to effectively sample the area from 50–300 m offshore. Within a few days, the band diminished in both strength and range allowing us to sample the 0–50 m stratum. We continued to use the offshore transducer for sampling the full 50-300 m range until we were able to detect bottom reflections and target echoes with the nearshore transducer beyond the 50 m range. As the season progressed, the reverberation reached it's peak amplitude during peak water level periods, diminishing as soon as the water level began to decline. Range-dependent signal loss was experienced with both left-bank transducers during this same time (Figure 21). No signal loss was observed on the right bank during the course of the field season.

We used the fathometer to determine if the reverberation band could be found elsewhere on the river. Upstream of the left-bank sampling area, the band narrowed and disappeared at the start of the river bend. Downstream, the band widened and became heavier until a sand bar, termed Lower Sand Bar (Figure 4), downstream of the sampling area was reached. Beyond the sand bar, the reverberation band was no longer visible on the fathometer chart recording. Similar observations were made when aiming the left-bank transducer. As the beam was directed downstream, the reverberation band became wider and the reverberation echo amplitudes increased on the chart recording. In addition, the maximum detection range of bottom reflections and target echoes beyond the band lessened. Directing the beam upstream reversed the effect.

To compensate for the signal loss, we increased the transmit power and added gain as a function of range (dB/km) increasing our threshold levels by a maximum of 25 dB at peak signal loss (Appendix A). This was the maximum gain we were able to induce; further increases reduced the signal to noise ratio to unacceptable levels. When signal loss exceeded 25 dB, the effective ensonified range decreased. We adjusted the range ensonified by each transducer, increasing the area sampled by the left-bank offshore transducer as necessary and directed the beam toward a stronger upstream aspect. Toward the end of the season, we increased the pulse width to 0.6 ms to further increase the signal power. In past seasons, bottom reflections from the silty, sandy left-bank bottom were detected in the range of -40 to –46 dB. Our lowest threshold, –46 dB, is used to detect faint bottom reflections to verify bottom-oriented aim. The majority of fish targets are detected at amplitudes greater than our third threshold level of –39 dB, 7 dB above the faint bottom echoes. This allowed us to use the bottom echo amplitude as a reference for adjusting our threshold levels. If bottom reflections were visible throughout the range, we felt confident the system would detect the larger salmon-sized echoes. We attempted to estimate the degree of signal loss whenever time and weather conditions permitted by measuring the target strength of a standard target *in situ*.

Target strength estimates of the 4.2 kg, 10.2 cm lead target were highly variable, but all indicated signal loss from the approximate expected value of –28 dB (Table 8). DSO target strength estimates of the 38.1 mm stainless steel target also indicated signal loss (Table 9). In two cases (31 July and 23 August) the target strength values were obtained at close range (23 m) where signal loss had not been observed. Both of these cases showed a target strength close to that expected of the stainless steel target (-40 dB). In each of the longer range measurements, target strength measures indicate signal loss close to the lowered threshold level necessary for sampling on that same day. In each case, these target strength values supported the lowered threshold levels. The maximum signal loss we measured was 26 dB. The dual beam data did not show these same levels of signal loss. The average target strength of the stainless steel target was approximately –40 dB or higher except on 18 August, when it showed a possible loss of 5 dB.

DISCUSSION

The dynamic water level, associated nearshore reverberation, and reductions in acoustic signal intensity presented challenges to the 1997 Yukon River sonar project. Although the heavy debris load and loss of signal caused interruptions in data collection during the summer run, harvestable surpluses of chinook and chum salmon were accurately identified in-season for fishery management purposes. Small harvestable surpluses of fall chum salmon were also successfully identified in-season for fishery management purposes.

Species apportionment test-fishing conditions this season wrecked havoc on project gill nets. We were forced to keep the nets out of the water during the heaviest debris passage (28 and 29 June), but underwater debris continued to tear up nets when we resumed fishing. We had just enough alternate nets on hand to continue sampling during the remainder of the season. It will be necessary to replace at least eight nets prior to the next field season.

We kept accurate records on the disposition of all captured fish. With the lower numbers of fish caught by villagers, project catches became more important.

We chose not to estimate the number of fish missed due to debris and loss of signal intensity during the last week of June and first days of July. Although we increased transmit power and receiver gain levels to obtain usable samples of data during periods of signal loss, the large continuous block of missing data is difficult to accurately estimate (Appendix C). Daily passage was estimated whenever we obtained at least one sampling period of sonar data during the day.

Few fish were detected beyond the sampling ranges with either the down-looking or side-scanning sonar. However, exact system sensitivies are unknown for either of the instruments used to detect fish in this region, as noted in a previous report (Maxwell et al, 1997). In fact, few fish were detected at all by these instruments. The sharp decline in fish passage versus range shown in the horizontal fish distribution plots (Figures 11 and 12) indicates that extending the sampling range would not significantly increase passage estimates.

More fish (12%) were estimated from routine expanded 9-hour sampling periods than from the corresponding 24-hour periods. The differences between the two measures are most likely caused by a combination of sampling uncertainty and environmental variables. Of necessity, 24-hour counts run through gillnet sampling periods. Gillnet fishing activity can interfere with fish behavior, lowering the estimate. This is especially a problem on the shallower left bank. However, in previous samples (Maxwell et al, 1997) the 24-hour estimates have been higher than the 9-hour estimates indicating that additional environmental variables may have an affect.

The bathymetric map created this season (Figure 4) provides a useful post-season snapshot of the river bottom structure, but was impossible to generate in-season because of time constraints. The Atchuelinguk River sand bar behaved very similar to behavior observed in previous seasons, remaining well upstream of the right-bank sampling area. The River Bend sand bar required closer monitoring, but also mimicked its behavior of the previous two years. Horizontal fish distribution plots (Figures 11 and 12) did not indicate any changes in fish migration patterns resulting from these sand bars.

Bottom profiles remained extremely linear off the left bank in 1997. We did not record any of the low sand dunes which dominated this region in the fall season of 1995 (Maxwell et al, 1997), and occurred to a much lesser extent in 1996 (Maxwell and Huttunen, 1998). At times it was difficult to determine whether our loss of bottom echoes was a result of signal loss or simply the lack of reflection off this smooth, silt-laden bottom.

Sampling was rarely interrupted by equipment problems. However, a few of the problems are noteworthy. It was necessary to schedule personnel for sonar sampling on both banks of the river for the entire field season because of the non-functioning radio telemetry equipment. We were able to reduce additional labor costs by re-scheduling crew from other activities, but this resulted in minimal maintenance of camp facilities and no maintenance of the gillnets, which cannot be continued in the future. In addition, one of the Model 401 digital chart recorder hand-held terminals failed. We obtained a replacement, but the replacement lacked numerous required functions. This failure did not reduce sampling time because we were able to use a back-up (Model 403) chart recorder on the right bank. Past experience with this particular chart recorder interface revealed large amounts of attendant electronic noise in the sonar system. Operating independently on separate banks alleviated this problem. The rotators worked well throughout the field season. All three rotators contained a gear ratio of 1551:1. These "slow" moving instruments made aiming easier and more precise. We encountered few chart recording printer problems this season. We replaced the print heads once each during the field season, which enhanced the charts and used fewer ribbons. We did encounter occasional electronic problems with the printers which resolved after allowing them to reset. The availability of back-up printers kept the loss of sampling time to a minimum.

Although we measured the strength and range of the reverberation band and documented the amount of signal loss, we have no data which explains the source of this problem. The problem didn't appear related to changes in conductivity nor was it caused by equipment anomalies or poor bottom profiles. We increased the intensity of our system analyses to search for the cause of the reverberation. The equipment functioned normally all season and bottom profiles remained satisfactory. We speculate that excessive signal scattering may be the cause. The Yukon River is normally silty. During flood events it has the capacity to carry a much larger load of large particulate matter which may scatter sound. The reverberation band may also result from particle deposition. The left-bank sampling area is approximately 380 m upstream of a large sand bar, termed Lower Sand Bar (Figure 4), in what appears to be a zone of deposition. The amplitude of reverberation echoes increased downstream toward the sand bar and diminished upstream. We charted selected regions between Pilot Station and Marshall with the fathometer, testing areas upstream of sand bars and areas without sand bars. The reverberation was found only in the areas upstream of sand bars (Figure 22). We have no explanation for this phenomena, only a record of where it appeared.

Overall, standard target data did not confirm nor countermand observed signal loss. We obtained target strength data on two targets. The first target, the lead downrigger weight, was used because it represents an approximately salmon-size target. It is much easier for us to find this target *in situ*. The non-uniformity of the lead weight target (somewhat oblong with numerous dents) coupled with it's relatively low compressional and shear velocities appear to render the lead weight a poor target. The target strength results (Table 8) are included only as a crude reference because we were unable to detect the much smaller stainless steel target at long ranges during periods of greatest signal loss. DSO target strength values for the stainless steel target support increasing threshold levels during sampling this season. The main weakness in this method is uncertainty in the target position. Although we took great care to maximize the target echoes, the limitations inherent in the DSO and the instability of target position in the strong current can induce a large degree of uncertainty in this measurement. Dual-beam data should provide more accurate target strength estimates because it accounts for target position in the beam, and provides more information about each echo, allowing filtering of noise-corrupted echoes. From echograms obtained during sampling, we know that we were experiencing signal loss which at times exceeded 25 dB over the 300 m range. Dual-beam target strength estimates failed to demonstrate this loss. More sampling effort will be necessary to determine the relative merits of using dual-beam standard target data to assess cumulative transmission loss.

Estimating fish passage in the Yukon River continues to present major technical and logistic challenges. The width of the river and dynamic nature of bottom sediments, hydrology, and fish behavior create a difficult sampling environment. This season, the water itself created new challenges with the appearance of the mysterious reverberation band and associated range-dependent signal loss. The hydroacoustic system that we employ in the Yukon River seems to work well for our purpose of detecting passing salmon. We were able to compensate for identified signal loss most of the time. With a less powerful system, we would have fewer operational options. Successful estimation of fish passage depends upon many factors, including an evenly-sloped bottom profile with an acoustically absorptive substrate material enabling a clear view of fish at long ranges, a good aim which optimizes fish detection, and constant attention to the frequent environmental changes which requires dilligent re-checking of all the parameters involved in the estimation process.

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Table 1. Pre-season Yukon River sonar equipment calibration data, 1997.

Sounder	Cables	Transducer	Receiver Gain L	Standard Volts In	Vdet NB 40	G1 NB 40	Vdet WB 40	G1 WB 40	0 dB cal NB 40	0 dB cal WB 40
101-039	1000' Belden 502Y/501Y	ITC 004 Case I	0	-3	3.49	-167.76	3.71	-167.22	2.89	3.05
101-039	1000' Belden 504Y/503Y	ITC 005 Case I	0	-3	3.29	-168.27	3.38	-168.03	2.89	3.05
101-036	1000' Carol 202/201	ITC 003 Case II	0	-8	2.1	-174.83	2.145	-174.65	4.91	5.43

Continued Sounder	Cables	Transducer	-13 dB Vs	-13 dB SL	-10 dB Vs	-10 dB SL	-6 dB Vs	-6 dB SL	-3 dB Vs	-3 dB SL	0 dB Vs	0 dB SL
101-039	1000' Belden 502Y/501Y	ITC 004 Case I	-5.15	209.69	-2.18	212.66	1.8	216.64	4.7	219.54	7.71	222.55
101-039	1000' Belden 504Y/503Y	ITC 005 Case I	-5.6	209.24	-2.4	212.44	1.4	216.24	4.1	218.94	7.35	222.19
101-036	1000' Carol 202/201	ITC 003 Case II	-2.43	206.70	0.52	209.65	4.44	213.57	7.39	216.52	10.41	219.54

Table 2. Daily estimates of fish passage by zone from 6 June to 18 July for the Yukon River sonar project, 1997.

Report Period	Date	Right Bank Passage	Std Error	Left Bank Nearshore[a] Passage	Std Error	Left Bank Offshore[b] Passage	Std Error	Total Passage	Std Error	Total Passage Coefficient of Variation	Percent Right Bank Passage	Percent Left Bank Passage
1	6/6/97	1,420	98			1,381	195	2,801	219	0.078	50.7	49.3
1	6/7/97	1,483	103			1,920	271	3,403	290	0.085	43.58	56.42
2	6/8/97	1,640	26			2,749	245	4,389	247	0.056	37.37	62.63
3	6/9/97	1,429	174			2,716	225	4,145	285	0.069	34.48	65.52
4	6/10/97	2,021	246	2,994		4,749	719	9,764	760	0.078	20.7	79.3
5	6/11/97	12,520	1819	16,661	3065	42,743	5762	71,924	6775	0.094	17.41	82.59
6	6/12/97	18,038	1342	17,962	3058	38,797	2791	74,797	4352	0.058	24.12	75.88
7	6/13/97	11,097	1372	16,225	1070	23,614	2827	50,936	3319	0.065	21.79	78.21
8	6/14/97	8,077	449	15,706	2852	18,650	1430	42,433	3222	0.076	19.03	80.97
9	6/15/97	4,840	357	5,496	761	8,651	1106	18,987	1389	0.073	25.49	74.51
9	6/16/97	6,126	451	6,871	952	17,670	2259	30,667	2493	0.081	19.98	80.02
10	6/17/97	8,965	831	10,342	1356	15,168	1589	34,475	2248	0.065	26	74
11	6/18/97	7,166	669	6,037	880	9,995	1224	23,198	1649	0.071	30.89	69.11
11	6/19/97	15,448	1442	21,657	3157	29,188	3574	66,293	4982	0.075	23.3	76.7
12	6/20/97	51,313	2449	69,266	6659	84,729	5753	205,308	9135	0.044	24.99	75.01
13	6/21/97	35,645	5744	42,641	6447	43,996	8627	122,282	12206	0.100	29.15	70.85
14	6/22/97	24,132	3140	25,493	4621	16,995	4545	66,620	7202	0.108	36.22	63.78
14	6/23/97	29,715	3866	24,152	4378	33,394	8931	87,261	10671	0.122	34.05	65.95
15	6/24/97	53,893	4138	61,440		26,623		141,956	4138	0.029	37.96	62.04
16	6/25/97	27,354	3269	20,640		14,880		62,874	3269	0.052	43.51	56.49
17	6/26/97	24,402	4591					24,402	4591	0.188		
18	6/27/97	23,678	1467			24,753	1661	48,431	2216	0.046	48.89	51.11
18	6/28/97	24,760	1534			18,420	1236	43,180	1970	0.046	57.34	42.66
	6/29/97											
19	6/30/97											
20	7/1/97	20,185						20,185				
21	7/2/97	15,959	575					15,959	575	0.036		
22	7/3/97	10,404	748					10,404	748	0.072		
22	7/4/97	9,409	676			3,115	123	12,524	687	0.055	75.13	24.87
23	7/5/97	12,848	1670			5,749	514	18,597	1747	0.094	69.09	30.91
24	7/6/97	14,375	297	2,616	1688	11,169	2732	28,160	3225	0.115	51.05	48.95
25	7/7/97	18,819	761	6,041	1202	17,960	2064	42,820	2506	0.059	43.95	56.05
26	7/8/97	21,920	1865	6,577	170	16,768	1543	45,265	2427	0.054	48.43	51.57
27	7/9/97	20,020	1201	21,481	4419	11,843	398	53,344	4596	0.086	37.53	62.47
28	7/10/97	14,307	725	22,438	2927	12,613	2023	49,358	3631	0.074	28.99	71.01
29	7/11/97	8,040	275	15,055	722	9,370	580	32,465	966	0.030	24.77	75.23
29	7/12/97	8,635	296	12,865	617	8,767	543	30,267	873	0.029	28.53	71.47
30	7/13/97	7,565	438	15,408	528	9,559	1361	32,532	1524	0.047	23.25	76.75
31	7/14/97	5,758	416	13,455	1056	8,557	727	27,770	1348	0.049	20.73	79.27
32	7/15/97	3,410	276	10,660	341	7,398	299	21,468	531	0.025	15.88	84.12
33	7/16/97	2,785	365	8,695	333	4,475	152	15,955	517	0.032	17.46	82.54
34	7/17/97	2,580	182	8,278	208	4,337	236	15,195	364	0.024	16.98	83.02
35	7/18/97	2,577	296	7,755	656	4,807	659	15,139	976	0.064	17.02	82.98
SUMMER TOTALS		594,758		514,907		618,268		1,727,933				

[a]Left Bank Nearshore Range: 0 - 70 m
[b]Left Bank Offshore Range: 70 - 300 m

Table 3. Daily estimates of fish passage by zone from 19 July to 31 August for the Yukon River sonar project, 1997.

Report Period	Date	Right Bank Passage	Std Error	Left Bank Nearshore[a] Passage	Std Error	Left Bank Offshore[b] Passage	Std Error	Total Passage	Std Error	Total Passage Coefficient of Variation	Percent Right Bank Passage	Percent Left Bank Passage
36	7/19/97	1,967	151	6,597	259	4,354	455	12,918	545	0.042	15.23	84.77
36	7/20/97	2,183	168	6,671	262	4,399	460	13,253	555	0.042	16.47	83.53
37	7/21/97	2,328	241	5,986	132	2,997	369	11,311	460	0.041	20.58	79.42
38	7/22/97	2,819	191	7,433	668	3,421	895	13,673	1133	0.083	20.62	79.38
39	7/23/97	2,261	391	11,392	1055	5,450	528	19,103	1243	0.065	11.84	88.16
40	7/24/97	2,344	58	11,254	564	4,413	508	18,011	764	0.042	13.01	86.99
41	7/25/97	2,721	357	11,997	694	4,311	29	19,029	781	0.041	14.3	85.7
42	7/26/97	3,307	278	15,911	1458	7,113	904	26,331	1738	0.066	12.56	87.44
43	7/27/97	7,783	874	32,803	4977	19,098	2342	59,684	5570	0.093	13.04	86.96
44	7/28/97	6,214	329	21,773	1208	14,196	718	42,183	1443	0.034	14.73	85.27
45	7/29/97	5,997	166	18,021	892	8,205	522	32,223	1047	0.032	18.61	81.39
46	7/30/97	4,101	459	15,306	2371	7,350	1287	26,757	2736	0.102	15.33	84.67
47	7/31/97	3,095	235	7,178	459	2,858	262	13,131	579	0.044	23.57	76.43
47	8/1/97	2,560	194	5,056	324	2,585	237	10,201	446	0.044	25.1	74.9
48	8/2/97	2,905	286	6,292	1301	4,185	1053	13,382	1698	0.127	21.71	78.29
49	8/3/97	2,606	412	7,030	1218	6,238	1193	15,874	1754	0.110	16.42	83.58
50	8/4/97	2,053	193	4,132	359	3,021	560	9,206	692	0.075	22.3	77.7
51	8/5/97	8,352	1625	15,253	3938	5,487	807	29,092	4336	0.149	28.71	71.29
52	8/6/97	14,512	558	43,530	2938	11,473	254	69,515	3001	0.043	20.88	79.12
53	8/7/97	9,952	572	26,209	3194	5,691	107	41,852	3246	0.078	23.78	76.22
54	8/8/97	4,649	292	12,431	632	5,102	761	22,182	1031	0.046	20.96	79.04
54	8/9/97	3,541	222	7,808	397	1,780	265	13,129	527	0.040	26.97	73.03
55	8/10/97	2,757	61	6,955	947	1,610	383	11,322	1024	0.090	24.35	75.65
56	8/11/97	2,345	196	4,041	122	709	57	7,095	238	0.034	33.05	66.95
57	8/12/97	3,066	470	6,464	613	2,812	943	12,342	1219	0.099	24.84	75.16
58	8/13/97	4,807	118	7,300	900	4,871	335	16,978	968	0.057	28.31	71.69
59	8/14/97	11,128	604	20,528	2048	7,168	266	38,824	2151	0.055	28.66	71.34
59	8/15/97	10,775	585	12,208	1218	5,987	222	28,970	1369	0.047	37.19	62.81
60	8/16/97	7,968	463	15,002	2208	9,352	1356	32,322	2633	0.081	24.65	75.35
61	8/17/97	7,128	242	13,804	590	9,215	1233	30,147	1389	0.046	23.64	76.36
62	8/18/97	5,960	232	10,520	2752	9,921	429	26,401	2795	0.106	22.57	77.43
63	8/19/97	6,265	228	15,719	1246	14,228	1565	36,212	2013	0.056	17.3	82.7
64	8/20/97	5,912	452	11,707	824	11,449	1956	29,068	2170	0.075	20.34	79.66
65	8/21/97	4,251	467	6,894	497	6,990	635	18,135	932	0.051	23.44	76.56
66	8/22/97	3,692	471	4,216	167	5,327	393	13,235	636	0.048	27.9	72.1
67	8/23/97	2,905	70	3,696	538	3,884	1113	10,485	1238	0.118	27.71	72.29
68	8/24/97	2,709	106	3,504	32	3,735	337	9,948	355	0.036	27.23	72.77
69	8/25/97	3,002	148	4,044	244	3,616	381	10,662	476	0.045	28.16	71.84
70	8/26/97	3,797	206	7,289	362	5,122	774	16,208	878	0.054	23.43	76.57
71	8/27/97	4,018	188	7,430	1566	5,025	454	16,473	1642	0.100	24.39	75.61
72	8/28/97	3,560	481	6,437	152	4,913	508	14,910	716	0.048	23.88	76.12
73	8/29/97	3,349	289	8,040	441	7,757	2675	19,146	2726	0.142	17.49	82.51
74	8/30/97	2,899	9	5,314	1060	6,963	3145	15,176	3319	0.219	19.1	80.9
75	8/31/97	2,861	267	2,869	233	5,595	227	11,325	421	0.037	25.26	74.74
FALL TOTALS		203,404		484,044		269,976		957,424				
SEASON TOTALS		798,162	12,128	998,951	17,525	888,244	18,859	2,685,357	28,458			

[a]Left Bank Nearshore Range: 0 - 70 m
[b]Left Bank Offshore Range: 70 - 300 m

Table 4. Cumulative passage estimates by species for the Yukon River sonar project, 1997.

SPECIES	CUMULATIVE ESTIMATED PASSAGE	STANDARD ERROR	COEFFICIENT OF VARIATION	*LOWER 90% CONFIDENCE INTERVAL	*UPPER 90% CONFIDENCE INTERVAL
Target Species					
Large Chinook Salmon	133,691	13,439	0.101	111,584	155,798
Small Chinook Salmon	90,399	15,765	0.174	64,465	116,333
	=========				
Total Chinook Salmon	224,090				
Summer Chum	1,411,233	30,213	0.021	1,361,533	1,460,933
Fall Chum	623,367	15,471	0.025	597,917	648,817
	=========				
Total Chum	2,034,600				
Non-target Species**					
Coho Salmon	153,502	8,855	0.058	138,936	168,068
Pink Salmon	3,282	1,861	0.567	220	6,344
Non-salmon	269,883	14,273	0.053	246,403	293,363
	=========				
TOTAL	2,685,357				

* Confidence intervals do NOT take into account lost sampling days.

**Estimates used in the process of apportioning target species, not for estimating passage rates of non-target species.

Table 5. Daily estimates of fish passage by species from 6 June to 18 July for the Yukon River sonar project, 1997.

REPORT PERIOD	DATE	LARGE CHINOOK	SMALL CHINOOK	SUMMER CHUM	NON-SALMON SPECIES	TOTAL ALL SPECIES
1	6/6/97	358	0	2,166	277	2,801
1	6/7/97	374	0	2,740	289	3,403
2	6/8/97	578	0	2,454	1,357	4,389
3	6/9/97	2,445	0	611	1,089	4,145
4	6/10/97	419	0	4,547	4,798	9,764
5	6/11/97	28,968	11,494	28,344	3,118	71,924
6	6/12/97	4,651	10,345	55,002	4,799	74,797
7	6/13/97	3,321	2,958	44,078	579	50,936
8	6/14/97	2,974	4,166	34,908	385	42,433
9	6/15/97	1,650	928	15,470	939	18,987
9	6/16/97	2,440	1,266	25,335	1,626	30,667
10	6/17/97	1,696	3,460	22,614	6,705	34,475
11	6/18/97	473	845	19,834	2,046	23,198
11	6/19/97	1,433	2,773	56,503	5,584	66,293
12	6/20/97	27,263	21,717	155,428	900	205,308
13	6/21/97	3,140	1,890	114,805	2,447	122,282
14	6/22/97	6,302	3,168	52,593	4,557	66,620
14	6/23/97	7,816	3,923	70,773	4,749	87,261
15	6/24/97	4,931	4,621	128,380	4,024	141,956
16	6/25/97	5,529	6,460	50,885	0	62,874
17	6/26/97	330	822	23,250	0	24,402
18	6/27/97	1,311	3,364	43,756	0	48,431
18	6/28/97	976	3,345	38,859	0	43,180
18	6/29/97					
19	6/30/97					
20	7/1/97	605	0	19,580	0	20,185
21	7/2/97	141	359	15,318	141	15,959
22	7/3/97	780	120	9,001	503	10,404
22	7/4/97	1,044	152	10,873	455	12,524
23	7/5/97	304	0	18,293	0	18,597
24	7/6/97	0	41	26,939	1,180	28,160
25	7/7/97	2,292	0	40,353	175	42,820
26	7/8/97	3,511	0	41,373	381	45,265
27	7/9/97	240	0	52,495	609	53,344
28	7/10/97	3,604	877	33,212	11,665	49,358
29	7/11/97	2,210	181	27,870	2,204	32,465
29	7/12/97	1,889	181	26,100	2,097	30,267
30	7/13/97	3,450	0	26,515	2,567	32,532
31	7/14/97	0	256	25,336	2,178	27,770
32	7/15/97	628	0	17,178	3,662	21,468
33	7/16/97	0	0	10,991	4,964	15,955
34	7/17/97	427	0	9,223	5,545	15,195
35	7/18/97	0	0	7,248	7,891	15,139
SUMMER TOTALS		130,503	89,712	1,411,233	96,485	1,727,933

Table 6. Daily estimates of fish passage by species from 19 July to 31 August for the Yukon River sonar project, 1997.

REPORT PERIOD	DATE	LARGE CHINOOK	SMALL CHINOOK	PINK	FALL CHUM	COHO	NON-SALMON SPECIES	TOTAL ALL SPECIES
36	7/19/97	0	0	61	10,144	0	2,713	12,918
36	7/20/97	0	0	67	10,413	0	2,773	13,253
37	7/21/97	740	0	0	5,340	0	5,231	11,311
38	7/22/97	2,448	0	0	6,259	0	4,966	13,673
39	7/23/97	0	404	0	10,220	0	8,479	19,103
40	7/24/97	0	0	43	4,579	0	13,389	18,011
41	7/25/97	0	0	0	8,650	0	10,379	19,029
42	7/26/97	0	283	48	13,289	0	12,711	26,331
43	7/27/97	0	0	0	57,008	0	2,676	59,684
44	7/28/97	0	0	0	35,548	0	6,635	42,183
45	7/29/97	0	0	0	28,946	115	3,162	32,223
46	7/30/97	0	0	694	21,223	688	4,152	26,757
47	7/31/97	0	0	0	7,834	564	4,733	13,131
47	8/1/97	0	0	0	6,238	466	3,497	10,201
48	8/2/97	0	0	0	3,197	113	10,072	13,382
49	8/3/97	0	0	0	3,783	0	12,091	15,874
50	8/4/97	0	0	0	5,310	200	3,696	9,206
51	8/5/97	0	0	0	27,985	388	719	29,092
52	8/6/97	0	0	0	65,270	1,286	2,959	69,515
53	8/7/97	0	0	0	39,906	1,816	130	41,852
54	8/8/97	0	0	0	8,302	3,409	10,471	22,182
54	8/9/97	0	0	0	4,051	2,400	6,678	13,129
55	8/10/97	0	0	0	4,768	3,047	3,507	11,322
56	8/11/97	0	0	0	2,480	1,815	2,800	7,095
57	8/12/97	0	0	0	4,430	4,599	3,313	12,342
58	8/13/97	0	0	877	8,887	3,930	3,284	16,978
59	8/14/97	0	0	0	27,407	8,759	2,658	38,824
59	8/15/97	0	0	0	20,277	6,903	1,790	28,970
60	8/16/97	0	0	0	21,229	10,754	339	32,322
61	8/17/97	0	0	0	19,586	9,924	637	30,147
62	8/18/97	0	0	1,039	13,773	9,420	2,169	26,401
63	8/19/97	0	0	0	25,928	9,755	529	36,212
64	8/20/97	0	0	0	20,762	6,154	2,152	29,068
65	8/21/97	0	0	0	10,227	5,380	2,528	18,135
66	8/22/97	0	0	0	3,877	8,290	1,068	13,235
67	8/23/97	0	0	0	3,590	5,954	941	10,485
68	8/24/97	0	0	0	3,396	5,406	1,146	9,948
69	8/25/97	0	0	0	2,755	5,057	2,850	10,662
70	8/26/97	0	0	0	3,561	9,044	3,603	16,208
71	8/27/97	0	0	0	8,824	6,943	706	16,473
72	8/28/97	0	0	370	6,938	5,998	1,604	14,910
73	8/29/97	0	0	0	14,570	2,594	1,982	19,146
74	8/30/97	0	0	0	9,804	4,599	773	15,176
75	8/31/97	0	0	83	2,803	7,732	707	11,325
FALL TOTALS		3,188	687	3,282	623,367	153,502	173,398	957,424
SEASON TOTALS		133,691	90,399	3,282	623,367	153,502	269,883	2,685,357

Table 7. Twentyfour-hour sampling estimates compared with daily nine-hour sampling estimates for the Yukon River sonar project, 1997.

Date	Sampling Method	Right Bank Passage	Left Bank Nearshore Passage	Left Bank Offshore Passage	Total Passage	Total % Differences
6/19/97	24-hr	13,124	15,151	22,170	50,445	23.91%
	9-hr	15,448	21,657	29,188	66,293	
7/14/97	24-hr	6,477	13,620	8,811	28,908	-4.10%
	9-hr	5,758	13,455	8,557	27,770	
7/29/97	24-hr	5,686	17,351	9,195	32,233	-0.03%
	9-hr	5,997	18,021	8,205	32,223	
8/19/97	24-hr	7,031	11,449	12,955	31,435	13.19%
	9-hr	6,265	15,719	14,228	36,212	
		=======	=======	=======	=======	
TOTAL	24-hr	32,318	57,571	53,131	143,021	11.99%
	9-hr	33,468	68,852	60,178	162,498	
% Differences by zone:		3%	16%	12%	12%	

Table 8. Target strength estimates of a 4.2 kg, 10.2 cm lead weight target (approximately -28 dB target) from digital storage oscilloscope (DSO) and dual-beam echosignal processor (DB ESP) measurements from the Yukon River sonar project, 1997.

Date	Range from active Transducer (m)	Transducer	Distance between Xducers (m)	DB ESP # Echoes prior to filtering	# Echoes after filtering	Std Dev (dB)	Avg TS (dB)	DSO peak TS (dB)	Avg TS (dB)
6/8/97	100	[1]LBOS	42					-41	-46
6/15/97	112	LBOS	72						-40
6/25/97	68	[2]LBNS						-57	-65
7/3/97	112	LBOS	60					-33	-39
7/7/97	155	LBNS						-43	-40
7/7/97	105	LBOS	50						-49
7/17/97	158	LBNS						-46	
7/19/97	112	LBNS						-38	-45
7/30/97	186	LBNS						-45	-52
7/31/97	24	LBNS						-31	-34
8/18/97	184	LBNS		22	14	4.1	-51	-56	-63
8/18/97	100	LBOS	86					-34	-41
8/23/97	22	LBNS		542	75	3.0	-32	-32	-36
8/28/97	179	LBNS		136	39	3.6	-48	-53	-57
8/28/97	82	LBOS	97	504	158	3.5	-44	-46	-49

[1]Left bank offshore transducer

[2]Left bank nearshore transducer

Table 9. Target strength estimates of a 38.1 mm stainless steel target (approximately -40 dB target) from digital storage oscilloscope (DSO) and dual-beam echosignal processor (DB ESP) measurements from the Yukon River sonar project, 1997.

Date	Range from active Transducer (m)	Transducer	Distance between Xducers (m)	DB ESP # Echoes prior to filtering	# Echoes after filtering	Std Dev (dB)	Avg TS (dB)	DSO peak TS (dB)	Avg TS (dB)	DSO signal loss (dB)	Left-Bank signal loss (dB)
6/8/97	98	[1]LBOS	42						-46	6	3
6/25/97	69	[2]LBNS						-56	-66	26	16
7/19/97	113	LBNS		1065	638	2.8	-37	-41	-46	6	7
7/30/97	186	LBNS						-51	-54	14	10
7/31/97	23	LBNS		2865	2576	3.8	-40	-37	-40	0	10
8/18/97	100	LBOS	86	337	293	3.8	-45	-38	-50	10	11
8/23/97	22	LBNS		631	553	4.6	-37	-40	-43	3	15
8/28/97	179	LBNS					*3	*3	*3		19
8/28/97	82	LBOS	97	610	317	2.2	-41	-53	-54	14	19

[1]Left bank offshore transducer

[2]Left bank nearshore transducer

[3]Note: Unable to find the stainless steel target

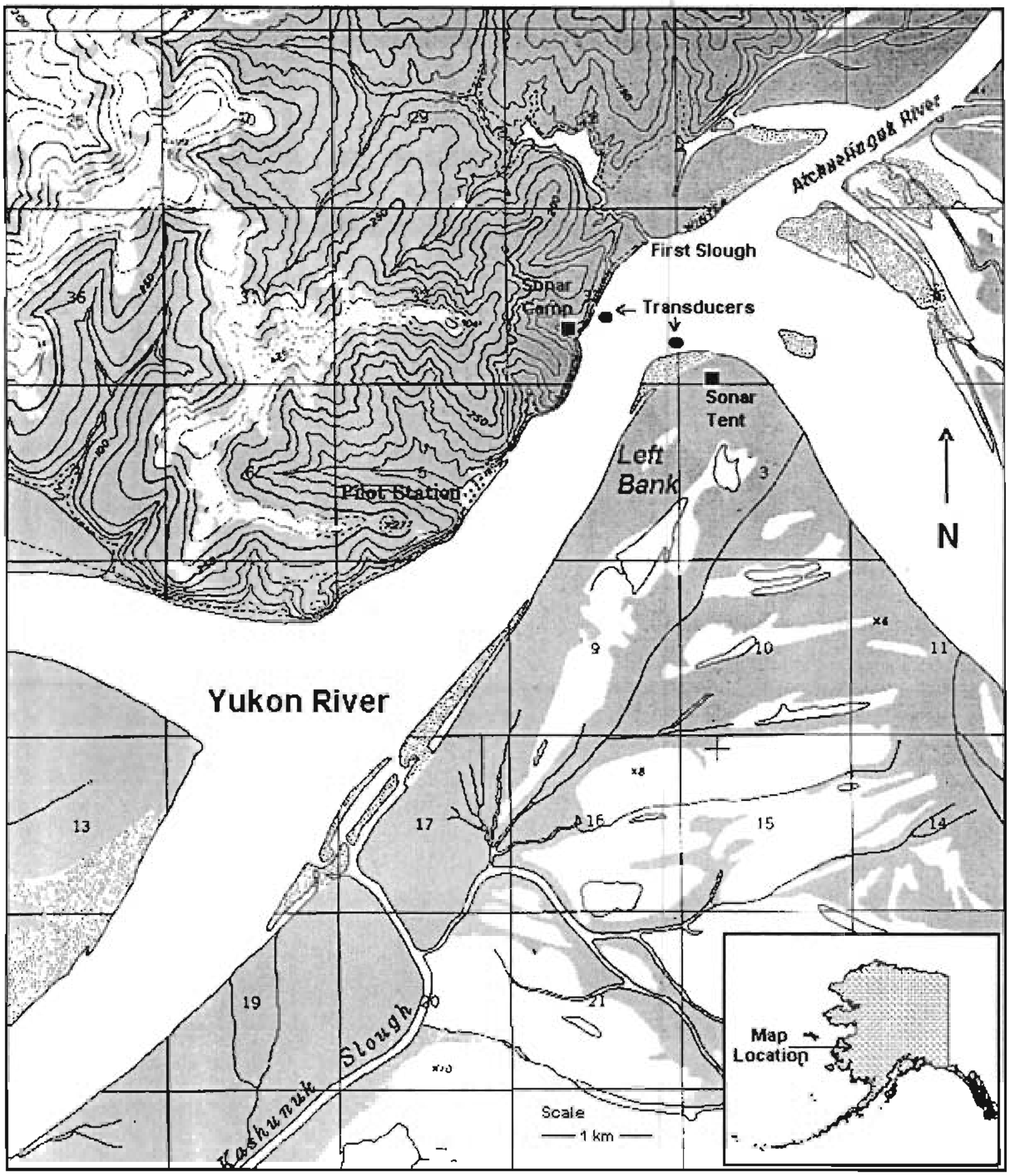


Figure 1. Topographical map of the Yukon River in the vicinity of the sonar site.

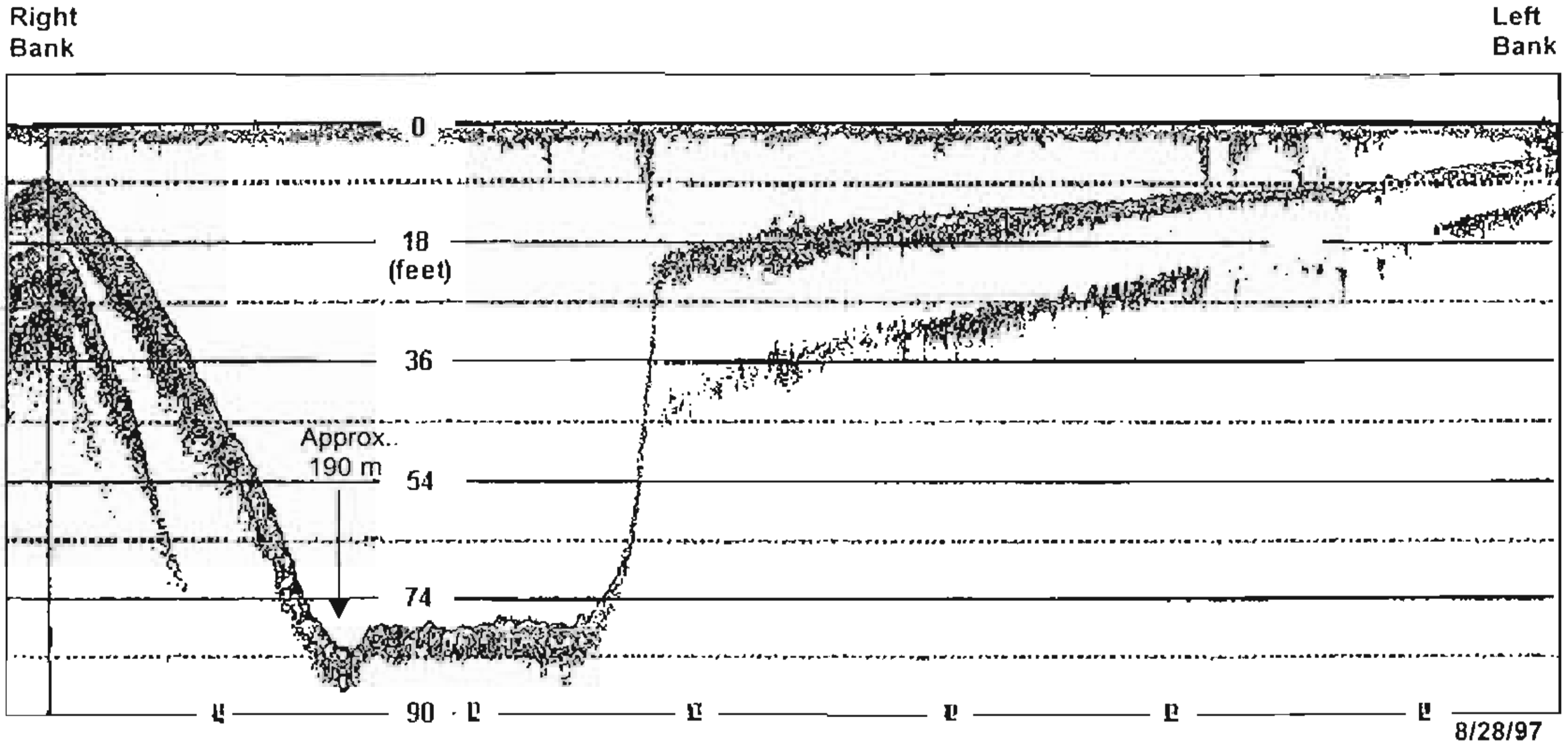


Figure 2. Yukon River bottom profile from the right-bank transducer to the left-bank transducer at the sonar project site, recorded on 28 August, 1997.

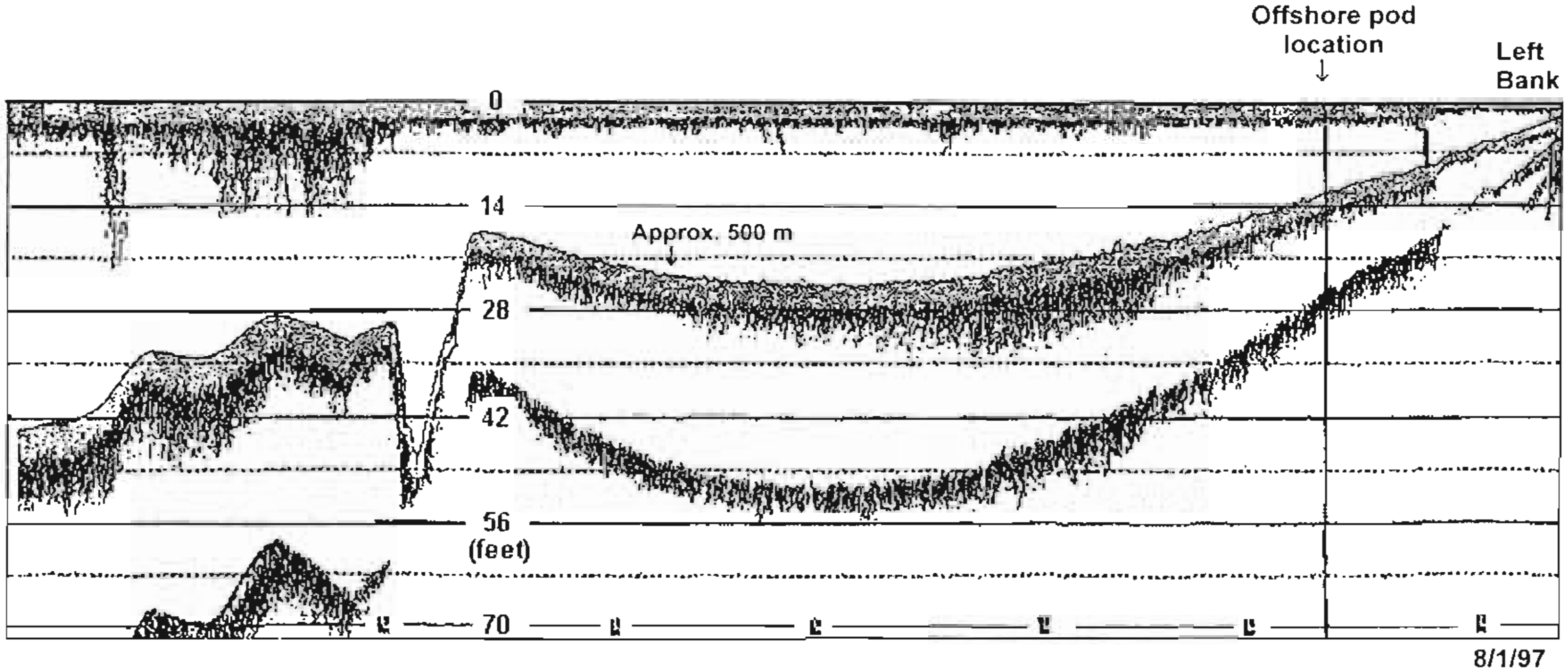


Figure 3. Yukon River left-bank profile recorded on 1 August. The upward slope past the 500 m point marks the down-stream edge of the River Bend sand bar beyond the sonar project's ensonified range, 1997.

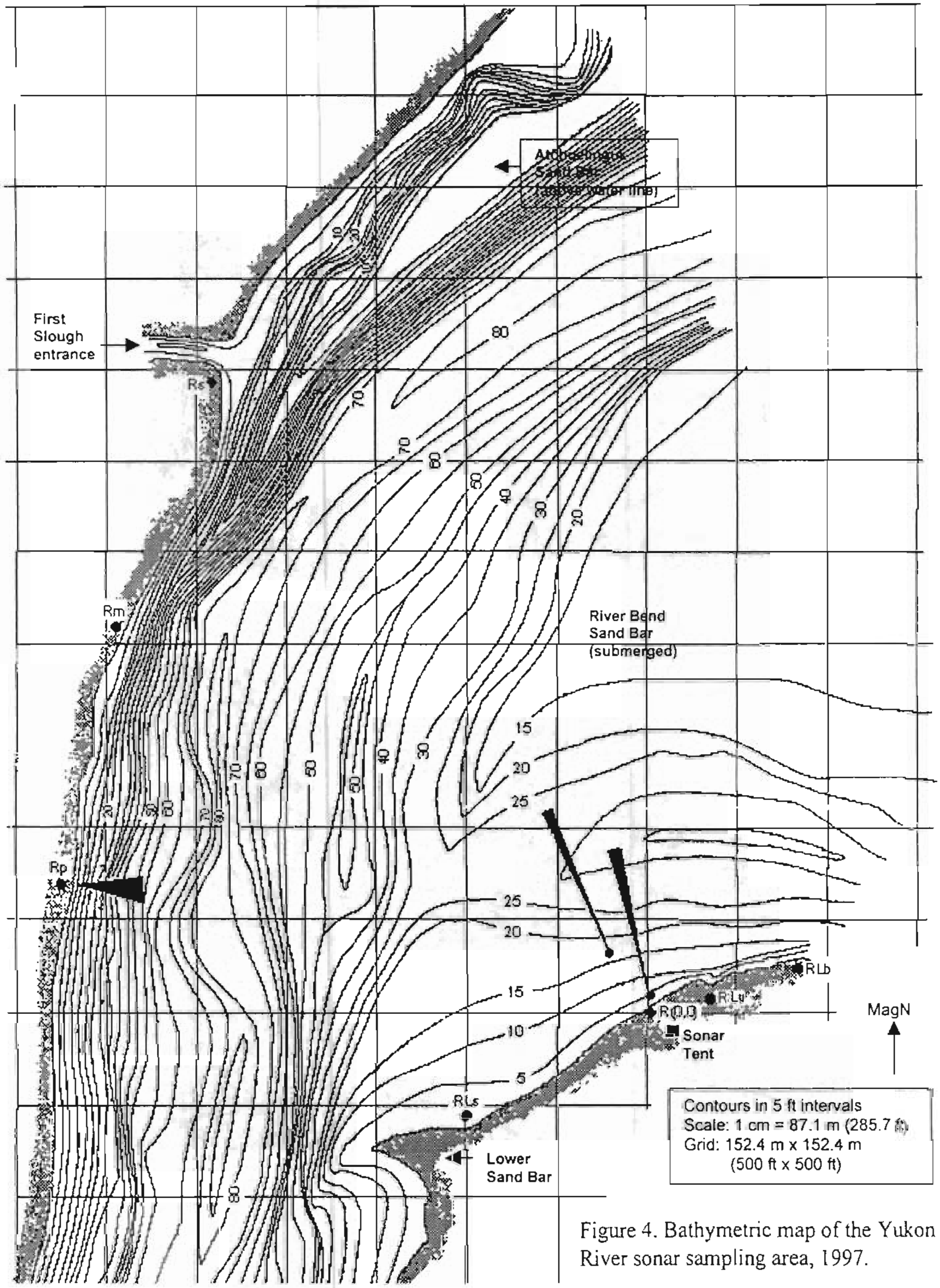


Figure 4. Bathymetric map of the Yukon River sonar sampling area, 1997.

Figure 5. Pictures of the debris load on the Yukon River taken on
29 June 1997 in front of the sonar camp.

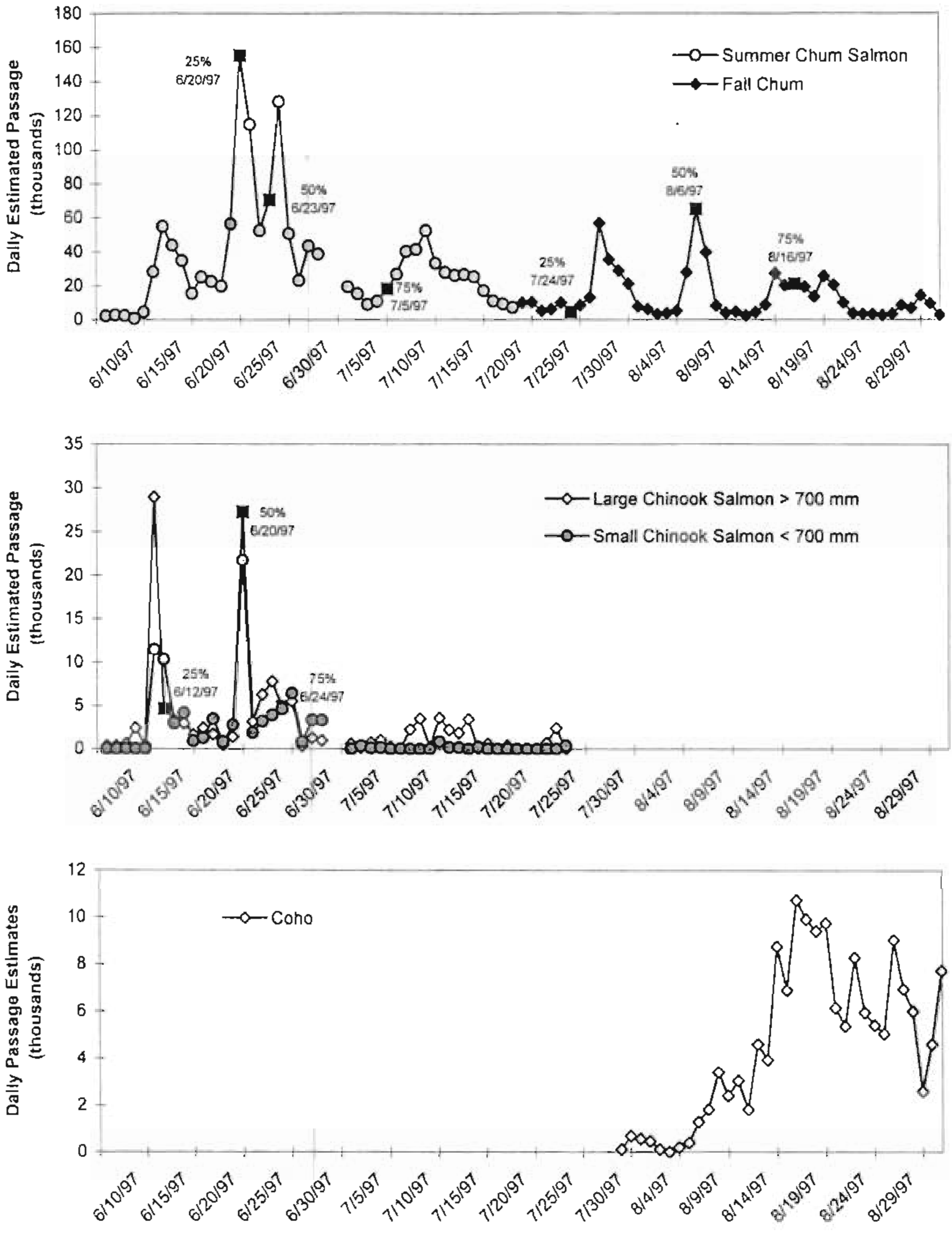


Figure 6. Daily estimated passage of chum, chinook, and coho salmon for the Yukon River sonar project, 1997. Solid black rectangles identify 25%, 50%, and 75% passage dates.

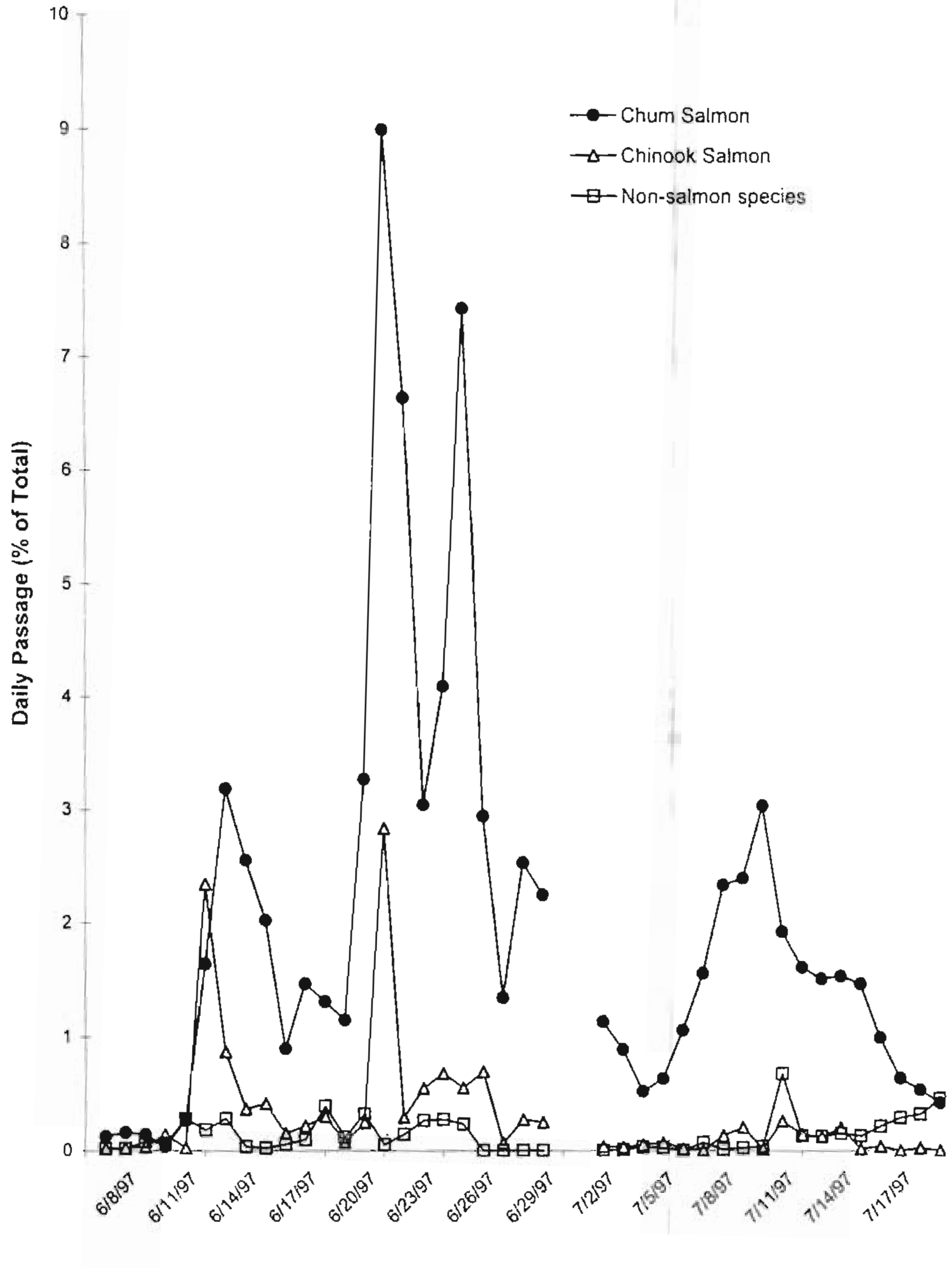


Figure 7. Daily proportions of fish passage by species from 6 June to 18 July for the Yukon River sonar project, 1997.

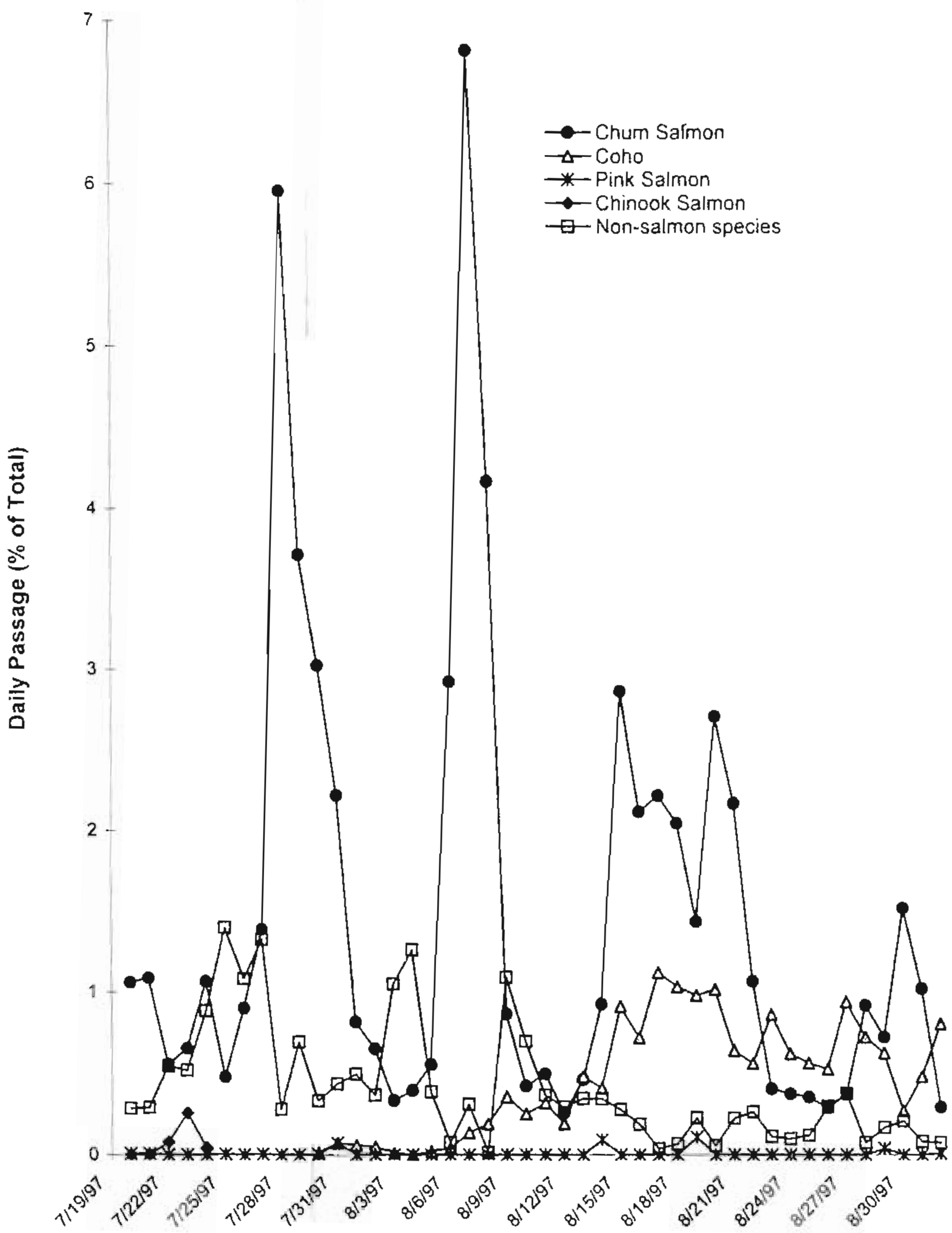


Figure 8. Daily proportions of fish passage by species from 19 July to 31 August for the Yukon River sonar project, 1997.

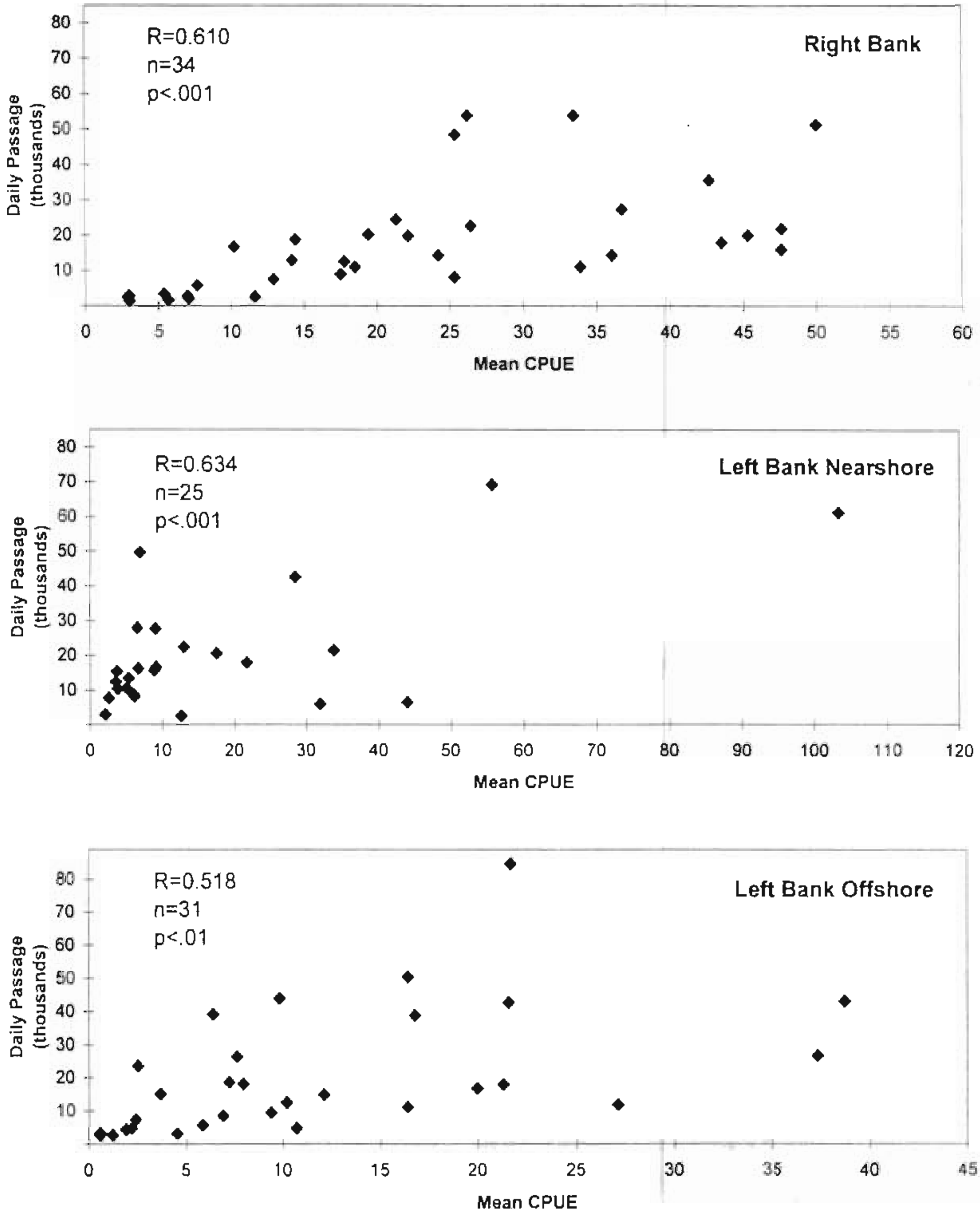


Figure 9. Mean CPUE species apportionment sampling versus daily sonar passage estimates by zone from 6 June to 18 July for the Yukon River sonar project, 1997.

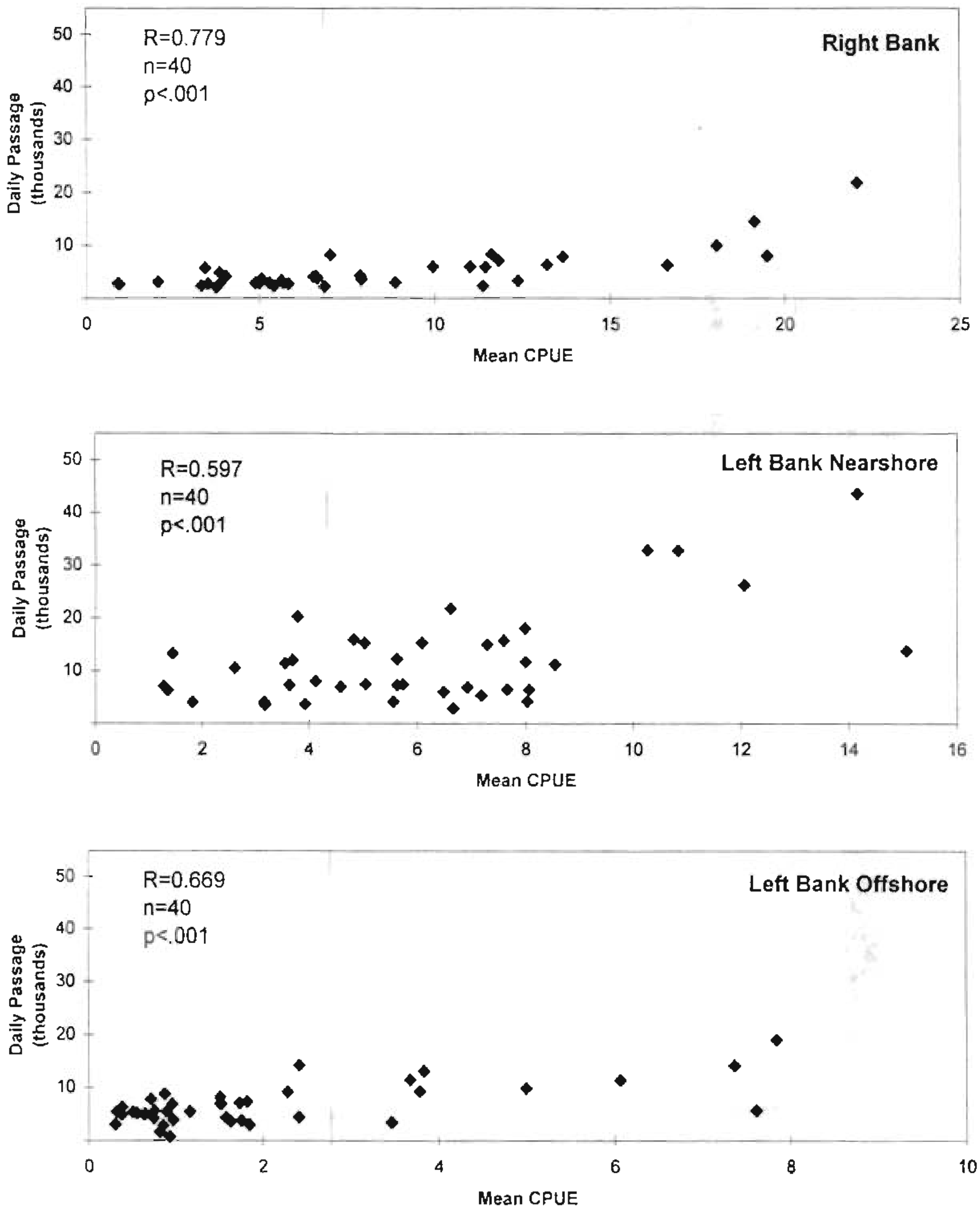
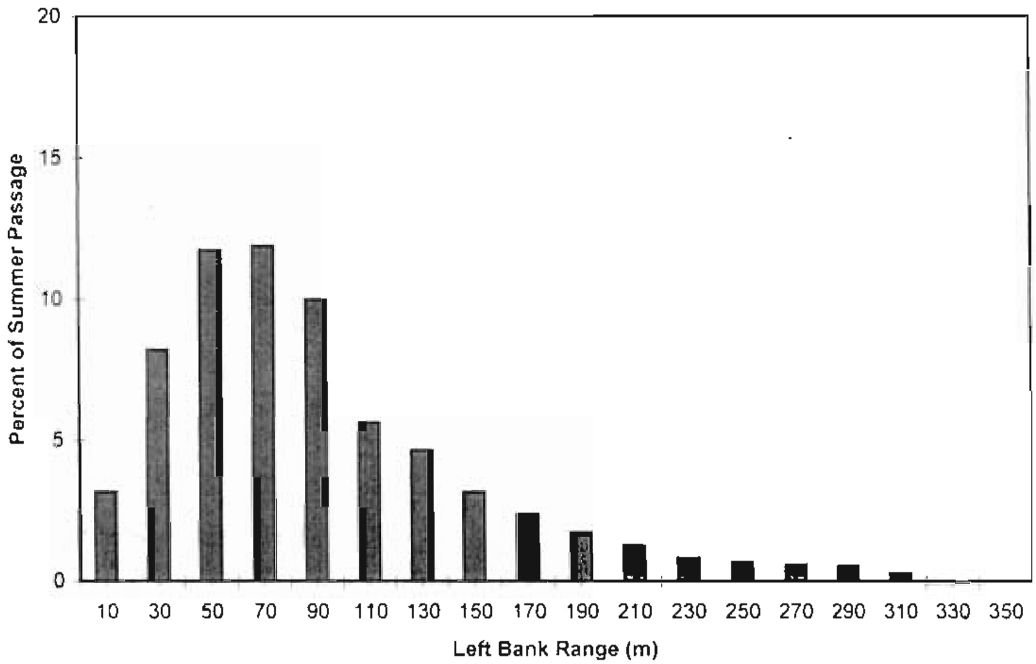


Figure 10. Mean CPUE species apportionment sampling versus daily sonar passage estimates by zone from 19 July to 31 August for the Yukon River sonar project, 1997.



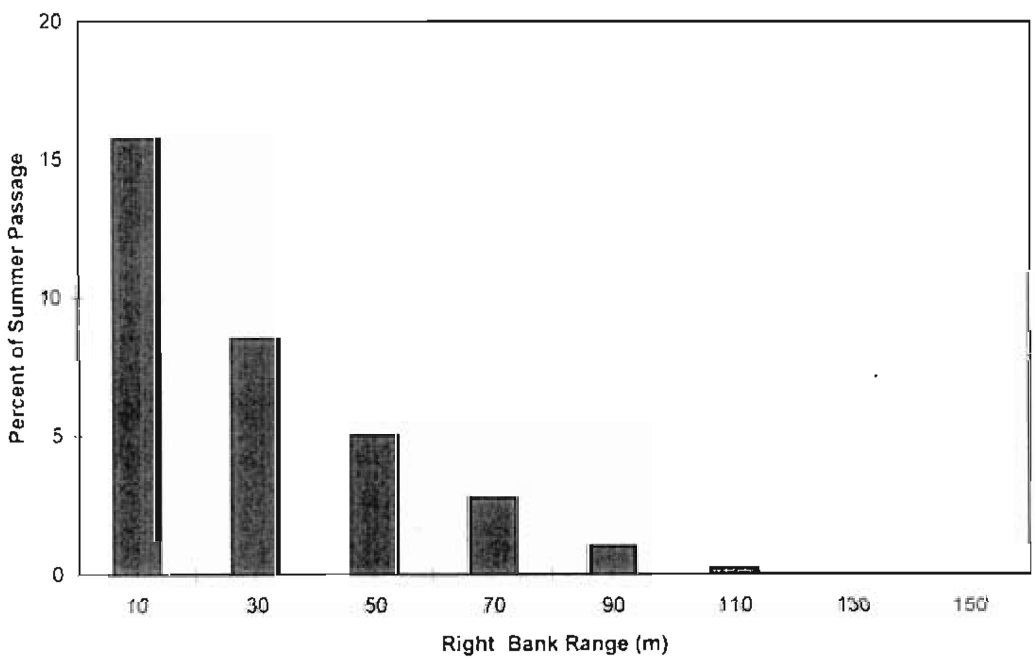
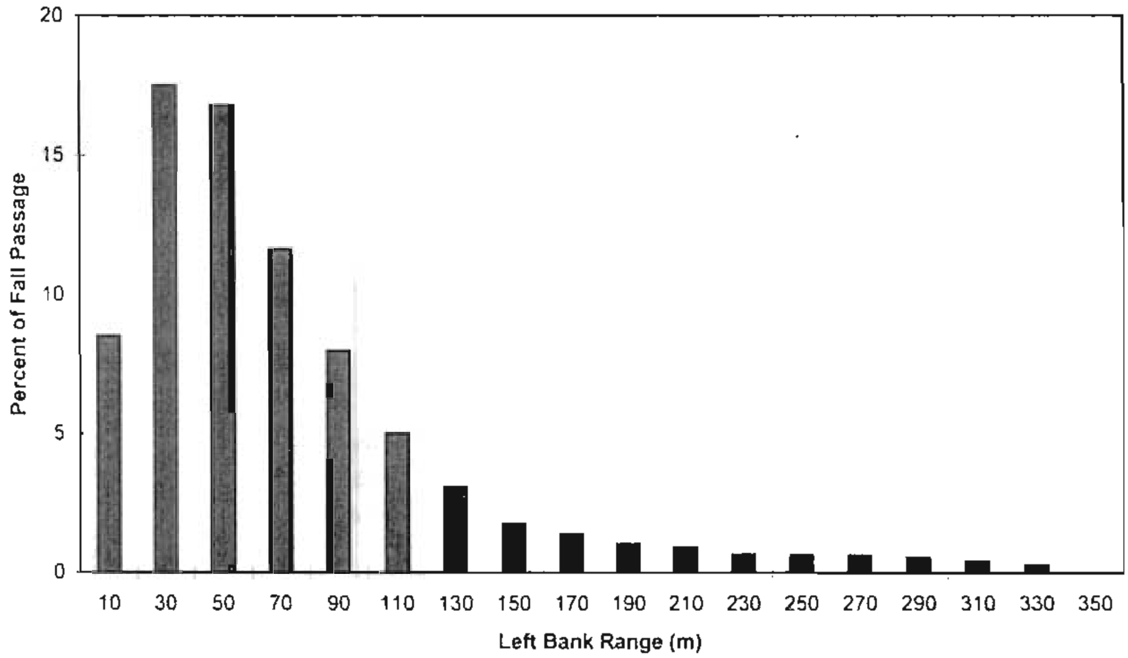


Figure 11. Horizontal distribution of left- and right-bank passage estimates for the Yukon River sonar project from 6 June through 18 July, 1997.



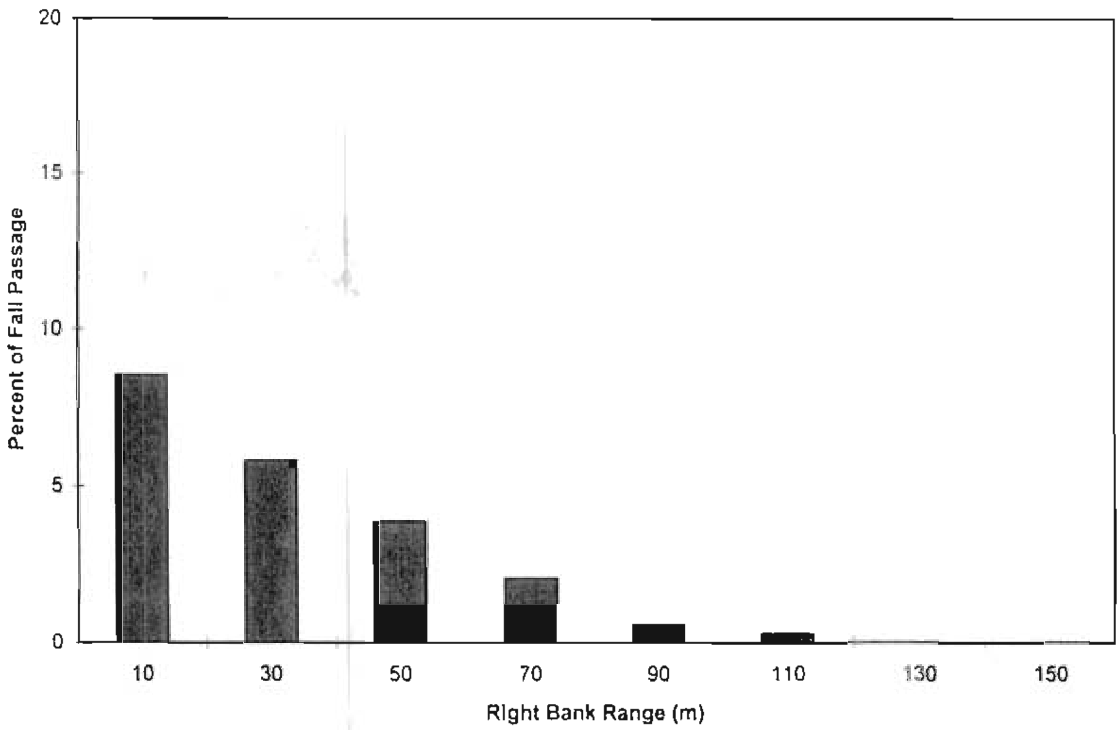


Figure 12. Horizontal distribution of left- and right-bank passage estimates for the Yukon River sonar project from 19 July through 31 August, 1997.

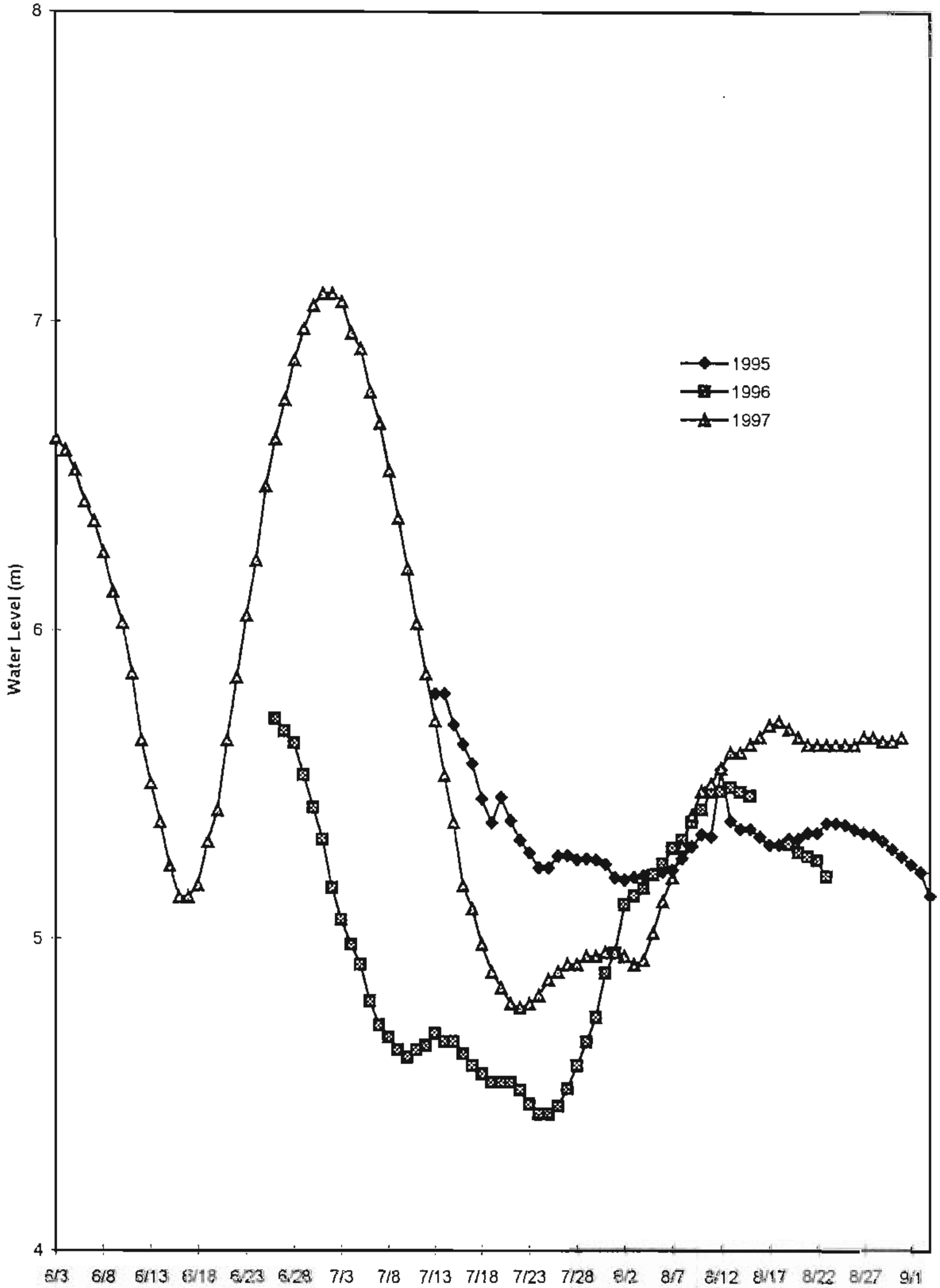


Figure 13. Yukon River daily water level measured in front of the sonar camp in 1995 1996, and 1997.

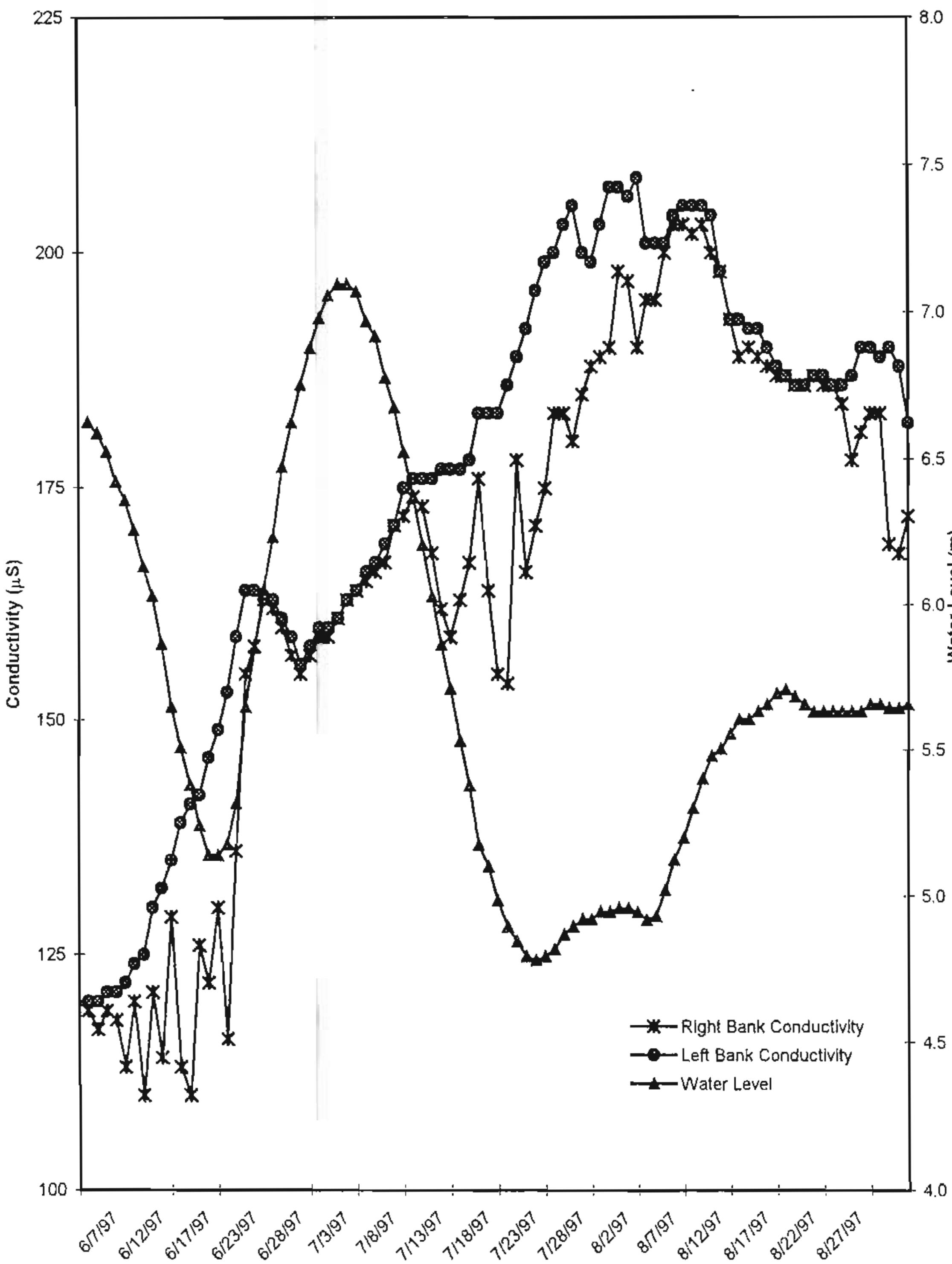


Figure 14. Daily conductivity and water level of the Yukon River recorded at the sonar project site, 1997.

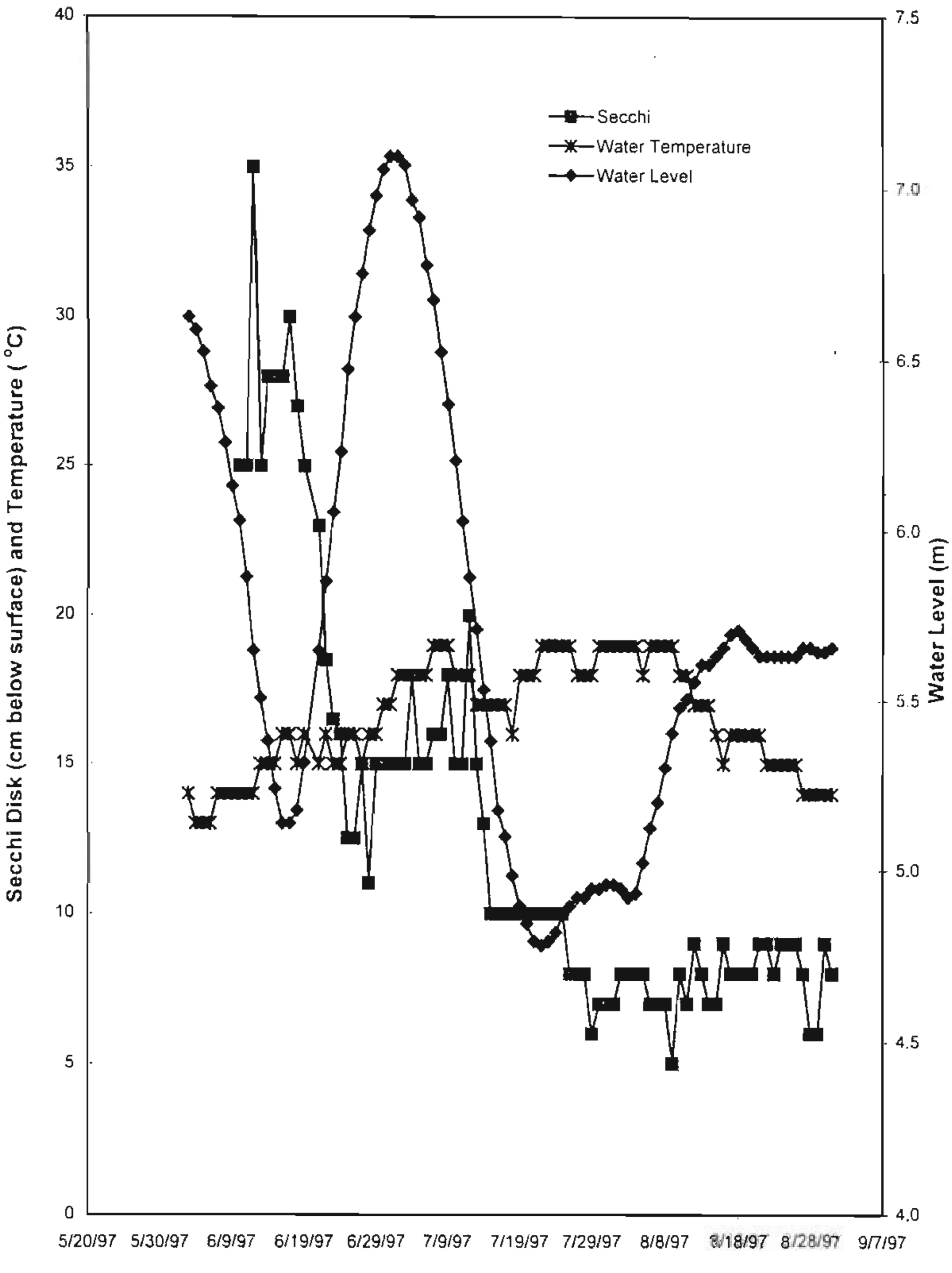
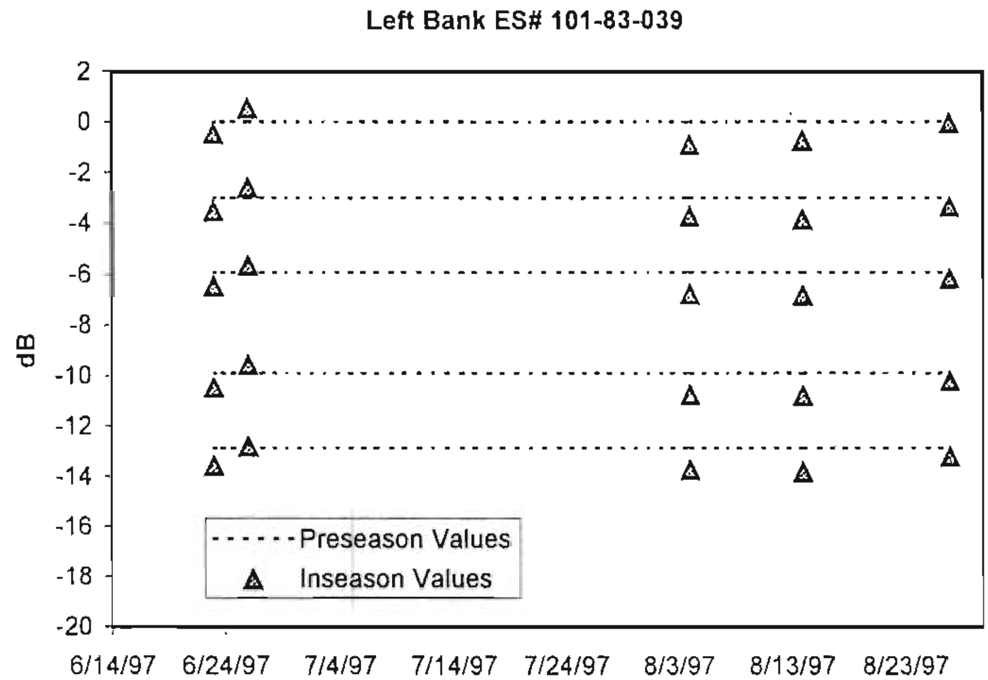


Figure 15. A comparison of secchi disk measurements, water level, and water temperature of the Yukon River at the sonar project site, 1997.



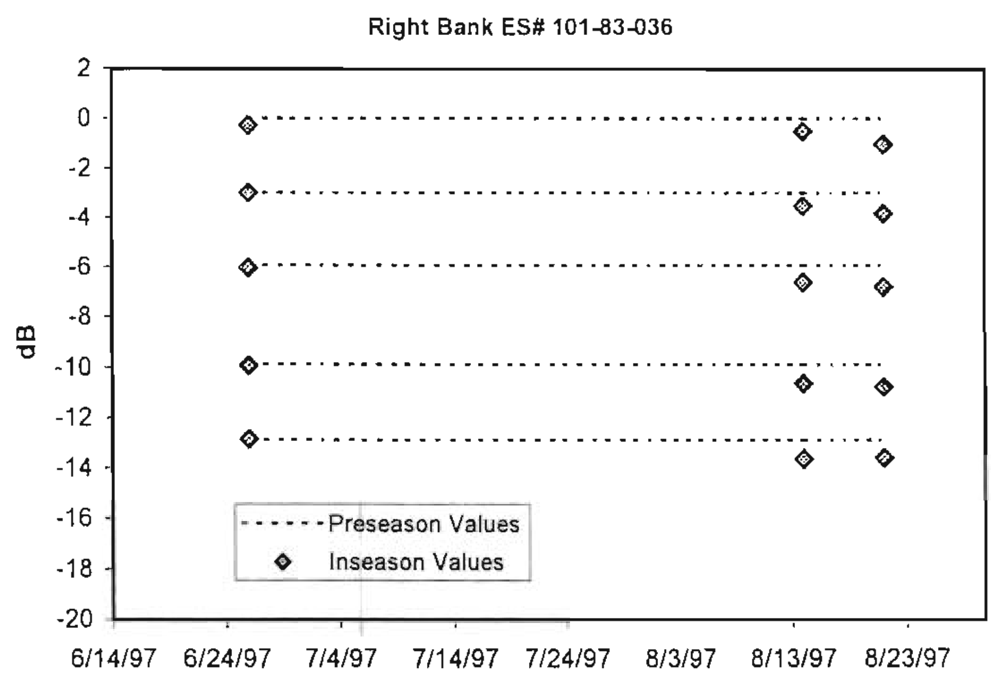


Figure 16. Transmitter output tests for the Yukon River sonar project's echosounders, 1997.

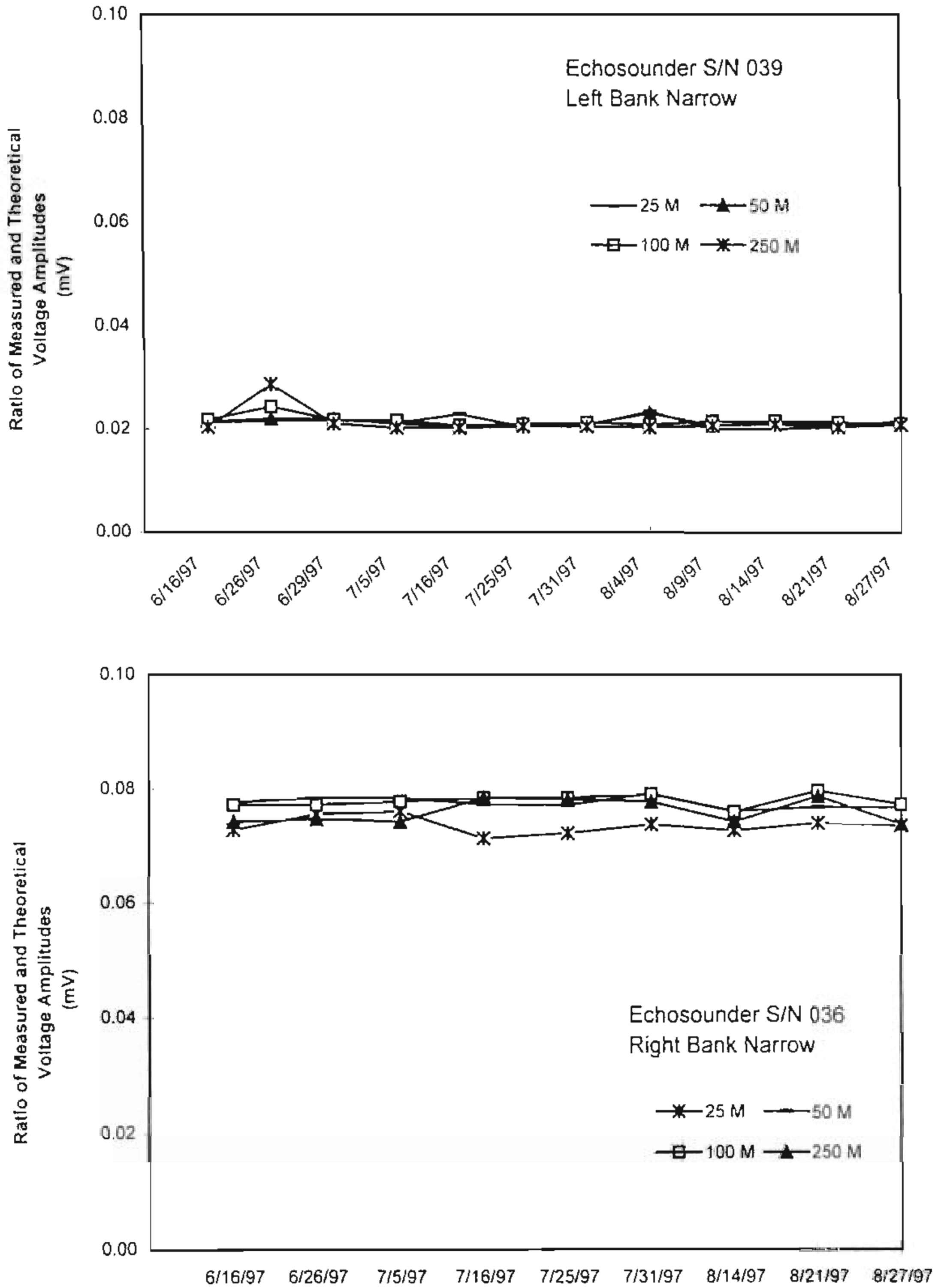


Figure 17. Time-varied gain performance verification of the narrow-beam channel for the Yukon River sonar project's echosounders, 1997.

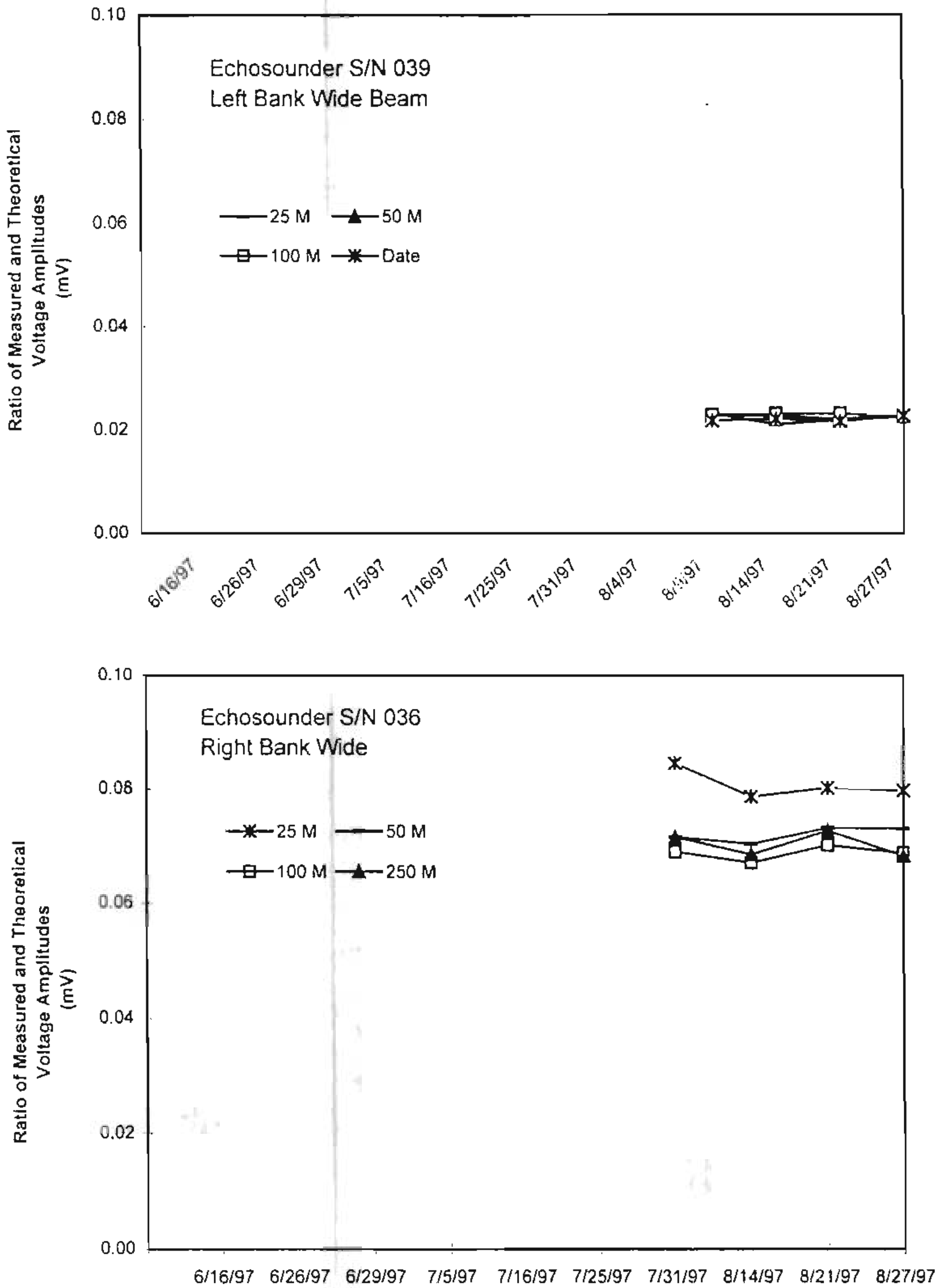
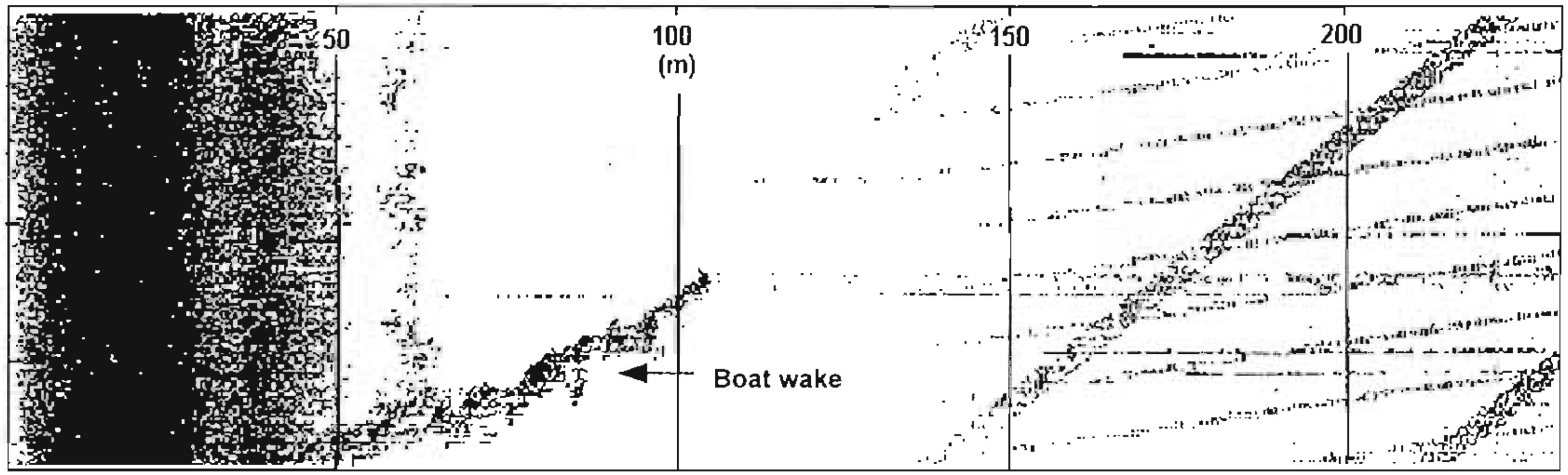


Figure 18. Time-varied gain performance verification of the wide-beam channel for the Yukon River sonar project's echosounders, 1997.



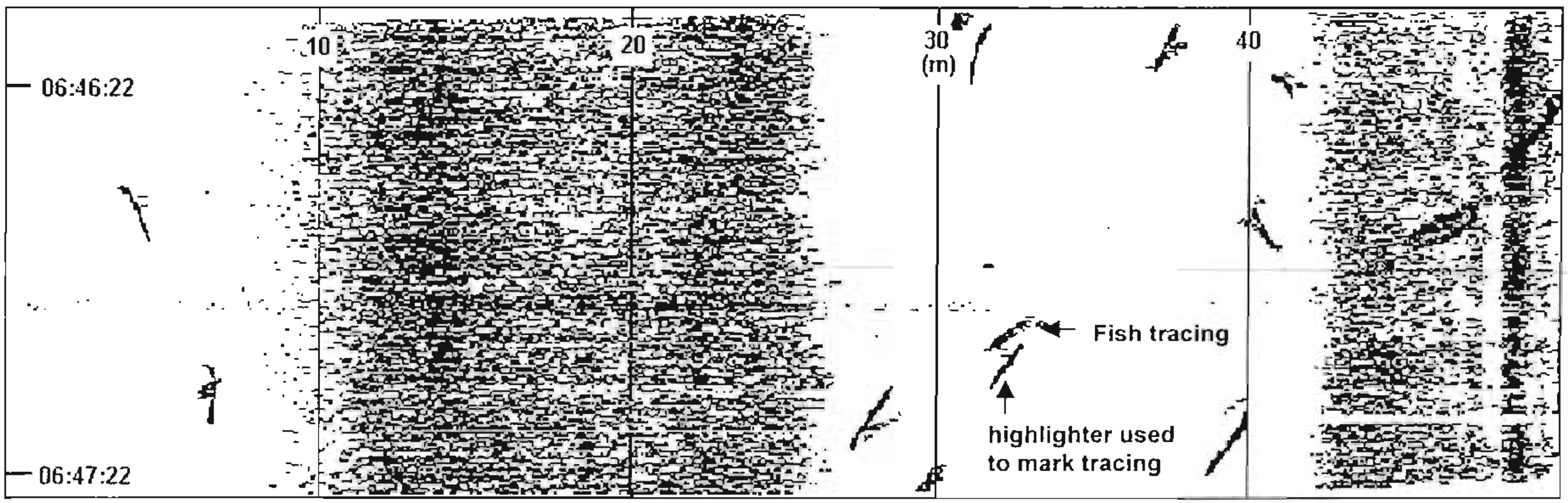


Figure 19. Digital chart recordings of the reverberation band in the Yukon River at the sonar project site, 1997. On 6 June (top), the only echoes able to penetrate from beyond the dense band are reflections off entrained air from a boat wake. On 11 June (bottom), the noise is dispersed enough to identify fish targets beyond it.

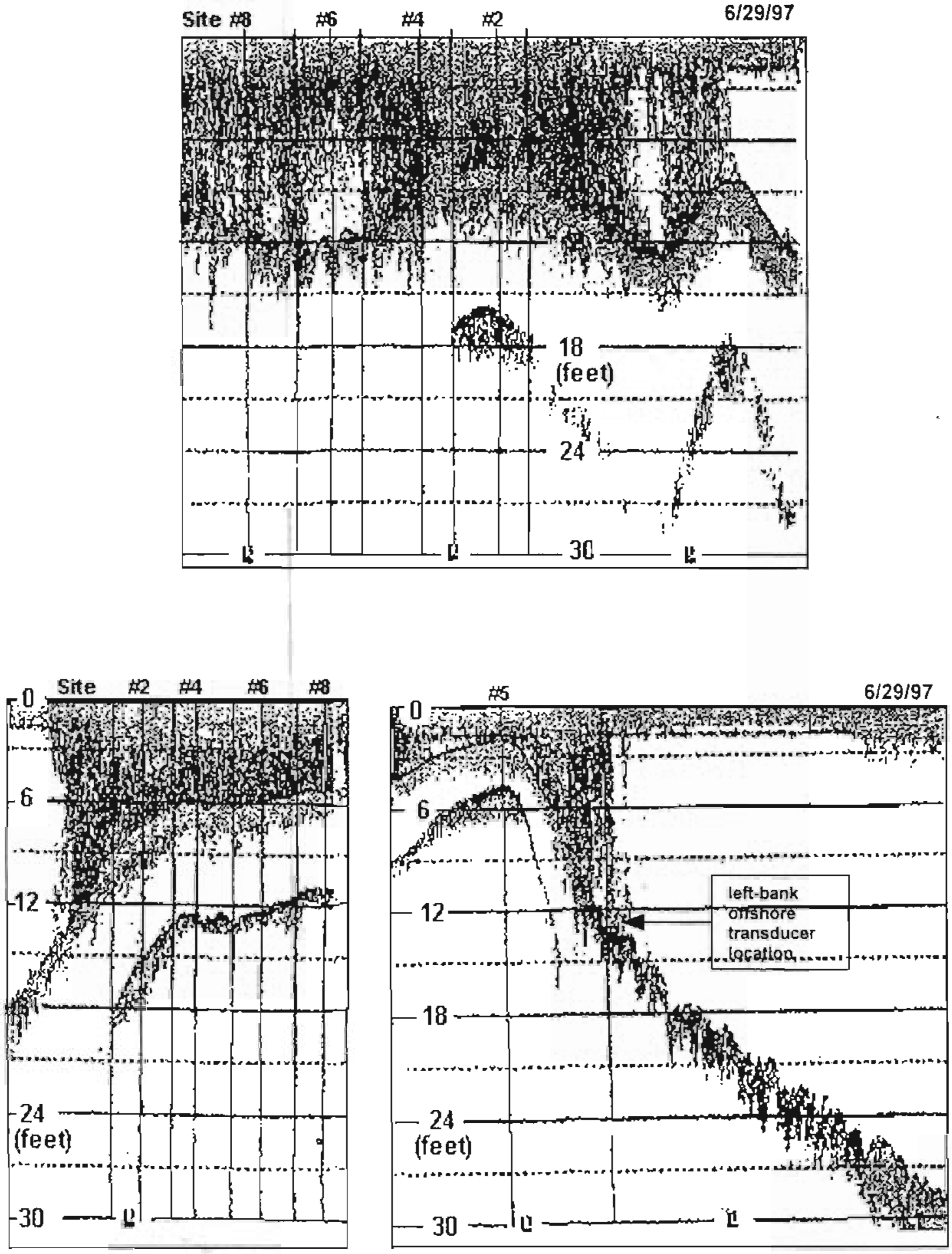


Figure 20. Fathometer chart recordings of the reverberation band 30 to 50 m offshore parallel to the left bank of the Yukon River (top and bottom left) and perpendicular from the left-bank transducer (Site #5) moving offshore (bottom right) at the sonar project site, 1997. Site markings are approximately 16 m apart.

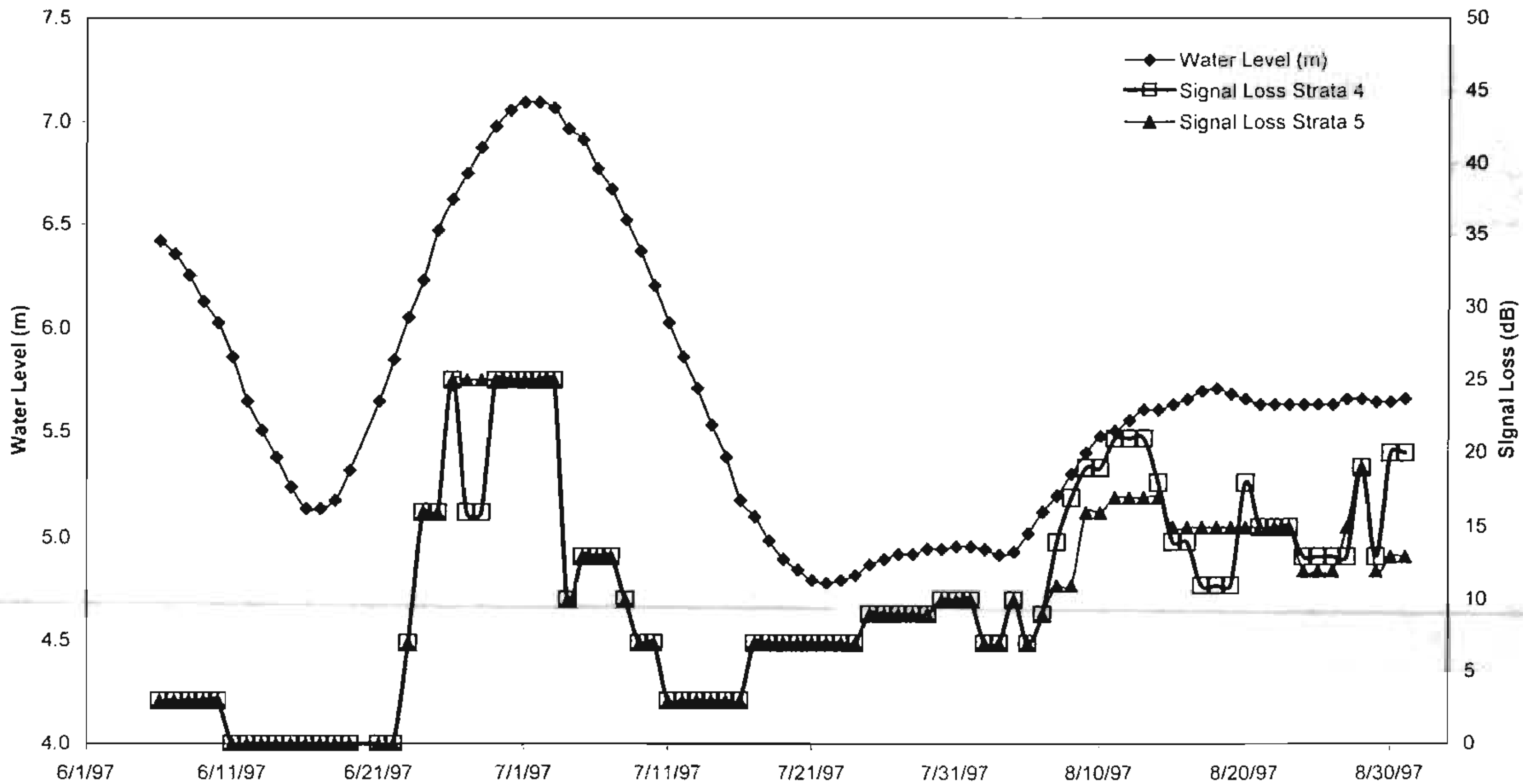


Figure 21. A daily comparison of Yukon River water level and signal loss determined from the increased threshold levels used during sampling at the sonar project, 1997.

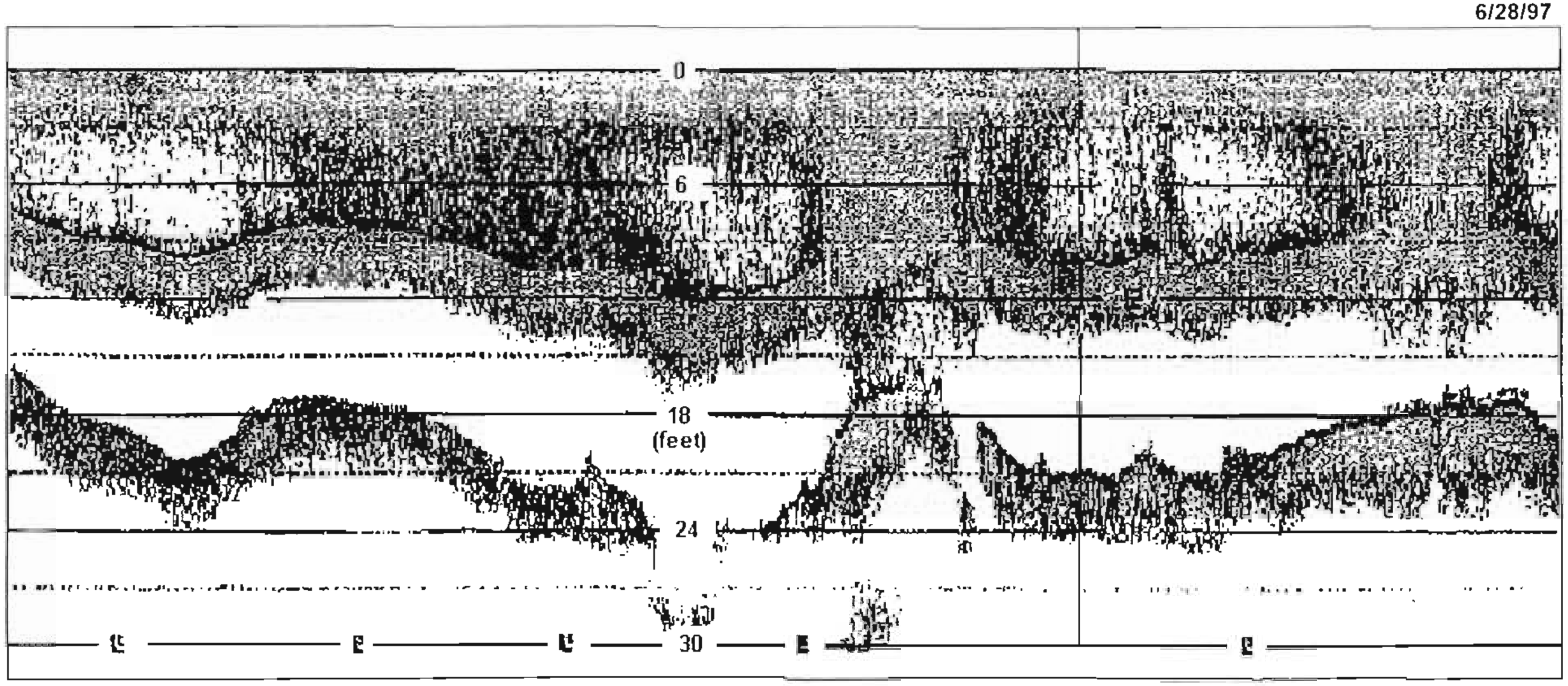


Figure 22. A fathometer chart recording of the reverberation phenomenon recorded several miles upriver from the Yukon River sonar camp and approximately 50 m from shore, 1997.

APPENDICES

Appendix A. Amplitude and range of the reverberation band observed sporadically during the 1997 Yukon River sonar field season, with daily equipment settings, estimated signal loss, and standard target strength estimates.

Water Level (m)	Date	Noise Band Ampl (dB)	Noise Band Range (m)	Tx dB	Strata 3 Added Gr or α (dB)	Tx dB	Strata 4 Added Gr or α (dB)	Tx dB	Strata 5 Added Gr or α (dB)	Pulse width mS	Strata 3 power increase dB	Strata 4 power increase dB	Strata 5 power increase dB	Stdtgt DSO lead dB	Stdtgt DSO steel dB	Stdtgt db lead dB	Stdtgt db steel dB	trans-ducer #	Stdtgt Range m	Comments
*6.6	6/3																			
6.6	6/4																			
6.5	6/5	-33	0-40																	
6.4	6/6	-43		no sig		-10	0	-10	0	0.4	no sig	3	3							
6.4	6/7	-49	0-25	no sig		-10	0	-10	0	0.4	no sig	3	3							
6.3	6/8		10-45	no sig		-10	0	-10	0	0.4	no sig	3	3	-46	-46			5	100	
6.1	6/9	-41	5-25	no sig		-10	0	-10	0	0.4	no sig	3	3							
6.0	6/10	-44	10-63	-10	0	-10	0	-10	0	0.4	3	3	3							
5.9	6/11	-49	10-25	-13	0	-13	0	-13	0	0.4	0	0	0							
5.6	6/12			-13	0	-13	0	-13	0	0.4	0	0	0							
5.5	6/13			-13	0	-13	0	-13	0	0.4	0	0	0							
5.4	6/14	-57	12-17	-13	0	-13	0	-13	0	0.4	0	0	0							
5.2	6/15			-13	0	-13	0	-13	0	0.4	0	0	0	-40				5	112	
5.1	6/16			-13	0	-13	0	-13	0	0.4	0	0	0							
5.1	6/17			-13	0	-13	0	-13	0	0.4	0	0	0							
5.2	6/18			-13	0	-13	0	-13	0	0.4	0	0	0							
5.3	6/19			-13	0	-13	0	-13	0	0.4	0	0	0							
	6/20			-13	0	-13	0	-13	0	0.4	0	0	0							
5.6	6/21			-13	0	-13	0	-13	0	0.4	0	0	0							
5.8	6/22			-13	0	-13	0	out	0	0.4	0	0	out							noise is back
6.1	6/23	-43	0-56	-6	0	-6	0	-6	0	0.4	7	7	7							
6.2	6/24	-42	0-53	-3	+6	-3	+6	-3	+6	0.4	16	16	16							
6.5	6/25	-47	0-90	-3	+6	-3	+6	-3	+6	0.4	16	16	16	-65	-66			4	69	
6.6	6/26	-42	0-80	no sig		no sig		no sig			no sig	no sig	no sig							
6.8	6/27	-45	0-105	no sig		-3	0	no sig			no sig	16	no sig							
6.9	6/28			no sig		-3	0	no sig			no sig	16	no sig							RB and LBOS out after period 1;
7.0	6/29																			Transducers out of water
7.1	6/30																			Transducers out of water
*7.1	7/1			no sig		no sig		no sig			no sig	no sig	no sig							
*7.1	7/2			no sig		no sig		no sig			no sig	no sig	no sig							
7.1	7/3	-48		no sig		no sig		no sig			no sig	no sig	no sig	-39				5	112	
7.0	7/4			no sig		-3	0	-3	0	0.4	no sig	10	10							Began sampling LB again.

*Peak water levels

-Continued-

Water Level (m)	Date	Noise Band Ampl (dB)	Noise Band Range (m)	Strata 3 Tx dB	Strata 3 Added Gr or α (dB)	Strata 4 Tx dB	Strata 4 Added Gr or α (dB)	Strata 5 Tx dB	Strata 5 Added Gr or α (dB)	Pulse width mS	Strata 3 power increase dB	Strata 4 power increase dB	Strata 5 power increase dB	Stdtgt lead dB	DSO steel dB	Stdtgt lead dB	db steel dB	trans-ducer #	Stdtgt Range m	Comments
6.9	7/5	-45	0-50	no sig		-3	6/km	-3	6/km	0.4	13	13	13							
6.8	7/6	-45	0-50	-3	6/km	-3	6/km	-3	6/km	0.4	13	13	13							
6.7	7/7			-3	6/km	-3	6/km	-3	6/km	0.4	13	13	13	-40				4	155	
6.5	7/8			-3	0	-3	0	-3	0	0.4	10	10	10							
6.4	7/9	-47	0-40	-6	0	-6	0	-6	0	0.4	7	7	7							
6.2	7/10			-6	0	-6	0	-6	0	0.4	7	7	7							Noise intense on LBOS.
6.0	7/11			-10	0	-10	0	-10	0	0.4	3	3	3							Noise narrower and lighter.
5.9	7/12	-54	0-25	-10	0	-10	0	-10	0	0.4	3	3	3							
5.7	7/13			-10	0	-10	0	-10	0	0.4	3	3	3							noise is less.
5.5	7/14			-10	0	-10	0	-10	0	0.4	3	3	3							
5.4	7/15	-50	25-29	-10	0	-10	0	-10	0	0.4	3	3	3							
5.2	7/16			-10	0	-10	0	-10	0	0.4	3	3	3							
5.1	7/17			-6	0	-6	0	-6	0	0.4	7	7	7	-46				4	158	Signal faded as we watched.
5.0	7/18			-6	0	-6	0	-6	0	0.4	7	7	7							
4.9	7/19			-6	0	-6	0	-6	0	0.4	7	7	7	-45	-46		-37	4	112	
4.8	7/20			-6	0	-6	0	-6	0	0.4	7	7	7							
4.8	7/21			-6	0	-6	0	-6	0	0.4	7	7	7							
4.8	7/22			-6	0	-6	0	-6	0	0.4	7	7	7							
4.8	7/23			-6	0	-6	0	-6	0	0.4	7	7	7							
4.8	7/24			-6	0	-6	0	-6	0	0.4	7	7	7							
4.9	7/25			-6	4/km	-6	4/km	-6	4/km	0.4	7	9	9							
4.9	7/26			-6	4/km	-6	4/km	-6	4/km	0.4	7	9	9							
4.9	7/27			-10	4/km	-6	4/km	-6	4/km	0.4	3	9	9							
4.9	7/28			-10	4/km	-6	4/km	-6	4/km	0.4	3	9	9							
4.9	7/29			-10	4/km	-6	4/km	-6	4/km	0.4	3	9	9							
4.9	7/30			-10	6/km	-6	6/km	-6	6/km	0.4	4	10	10	-52	-54			4	186	Signal faded as I watched.
5.0	7/31			-10	6/km	-6	6/km	-6	6/km	0.4	4	10	10	-34	-40		-40	4	23	
5.0	8/1			-10	6/km	-6	6/km	-6	6/km	0.4	4	10	10							Signal increasing.
4.9	8/2			-10	0	-6	0	-6	0	0.4	3	7	7							
4.9	8/3			-10	0	-6	0	-6	0	0.4	3	7	7							
4.9	8/4	-45	39-43	-10	6/km	-6	6/km	-6	6/km	0.4	4	10	10							
5.0	8/5			-10	0	-6	0	-6	0	0.4	3	7	7							
5.1	8/6	-51	30-37	-10	4/km	-6	4/km	-6	4/km	0.4	3	9	9							
5.2	8/7			-10	8/km	-3	8/km	-6	8/km	0.4	4	14	11							Noise increasing.

Appendix A. (Page 3 of 3)

Water Level (m)	Date	Noise Band Ampl (dB)	Noise Band Range (m)	Tx dB	Strata 3 Added Gr or α (dB)	Tx dB	Strata 4 Added Gr or α (dB)	Tx dB	Strata 5 Added Gr or α (dB)	Pulse width mS	Strata 3 power increase dB	Strata 4 power increase dB	Strata 5 power increase dB	Stdtgt lead dB	DSO steel dB	Stdtgt lead dB	db steel dB	trans-ducer #	Stdtgt Range m	Comments
5.3	8/8			-10	8/km	0	8/km	-6	8/km	0.4	4	17	11							Noise band narrow, strong.
	8/8			-10	12/km	-3	12/km	-3	12/km	0.4	4	16	16							Noise disappeared,still have sig loss
5.4	8/9			-10	12/km	0	12/km	-3	12/km	0.4	4	19	16							Noise is back and strongl
5.5	8/10			-10	12/km	0	12/km	-3	12/km	0.4	4	19	16							
5.5	8/11			-10	0	0	16/km	0	8/km	0.4	3	21	17							
5.6	8/12			-10	8/km	0	16/km	0	8/km	0.4	4	21	17							Noise disappeared.
5.6	8/13			-10	8/km	0	16/km	0	8/km	0.4	4	21	17							Noise back.
5.6	8/14			-10	8/km	-3	16/km	0	8/km	0.4	4	18	17							Noise strong, then weak.
5.6	8/15	-43	18-32	-10	8/km	-3	8/km	0	4/km	0.4	4	14	15							
5.7	8/16	-43	15-70	-10	8/km	-3	8/km	0	4/km	0.4	4	14	15							
5.7	8/17	-43	27-39	-10	8/km	-3	8/km	0	4/km	0.4	4	11	15							
*5.7	8/18			-10	8/km	-3	8/km	0	4/km	0.4	4	11	15	-63		-51		4	184	
	8/18			-10	8/km	-3	8/km	0	4/km	0.4	4	11	15	-41	-50		-45	5	100	Collected water samples
5.7	8/19			-10	8/km	-3	8/km	0	4/km	0.4	4	11	15							
5.7	8/20	-41	28-42	-10	10/km	0	10/km	0	4/km	0.4	4	18	15							
5.6	8/21			-10	10/km	-3	10/km	0	4/km	0.4	4	15	15							
5.6	8/22			-10	10/km	-3	10/km	0	4/km	0.4	4	15	15							noise strong
5.6	8/23			-10	10/km	-3	10/km	0	4/km	0.4	4	15	15	-36	-43	-32	-37	4	22	
5.6	8/24			-10	12/km	-6	12/km	-3	4/km	0.4	4	13	12							noise strong
5.6	8/25			-10	12/km	-6	12/km	-3	4/km	0.4	4	13	12							noise strong
5.6	8/26			-10	12/km	-6	12/km	-3	4/km	0.4	4	13	12							noise disappeared, strong dwnstrm
	8/26			-10	12/km	-6	12/km	0	4/km	0.4	4	13	15							signal fading...
5.7	8/27			-10	12/km	-6	12/km	0	4/km	0.4	4	13	15							noise strong,signal fading..
5.7	8/28			-10	12/km	0	12/km	0	12/km	0.5	4	19	19	-57		-48		4	179	Can't find stainless steel target.
	8/28			-10	12/km	0	12/km	0	4/km	0.6	4	19	15	-49	-54	-44	-41	5	82	
	8/29			-10	12/km	0	12/km	0	4/km	0.6	4	19	15							
5.6	8/29			-10	12/km	-6	12/km	-3	4/km	0.6	4	13	12							noise less, than more
5.6	8/30	-48	34-40	-10	0	-3	20/km	0	0	0.6	3	20	13							
5.7	8/31			-10	0	-3	20/km	0	0	0.6	3	20	13							

Appendix B. SAS program code used to generate passage estimates and variances for the Yukon River sonar project, 1997.

```
************************************************************************
************************************************************************
**                                                                    **
** FILE: yuk97v2.sas                                                  **
** TITLE: 1997 Yukon River Sonar Data Processing Program              **
** PLATFORM: SAS 6.12                                                 **
** DATE: 12 June, 1997                                                **
**                                                                    **
************************************************************************
************************************************************************
* 1.0 SET TITLE AND PAGE LENGTH AND WIDTH FOR OUTPUT.                  *
***********************************************************************;
title1 'YUKON RIVER SONAR - 1997 DATA PROCESSING PROGRAM - Version 2';
options linesize=132 pagesize=50;

************************************************************************
************************************************************************
**                                                                    **
** 2.0 INPUT REPORTING PERIOD DEFINITIONS.                            **
**                                                                    **
************************************************************************
************************************************************************
* 2.1 READ REPORTING PERIODS FROM AN EXTERNAL ASCII FILE.              *
***********************************************************************;
data rptdays;
  infile 'd:\ydata\y97 \rptper97.dat' firstobs=8;
  informat day mmddyy8.;
  format day date7.;
  input report day plotchar$;
  label report='REPORT PERIOD'
        plotchar='PLOTTING CHARACTER';
run;
************************************************************************
* 2.2 COMPUTE NUMBER OF DAYS IN EACH REPORT PERIOD.                    *
***********************************************************************;
proc summary data=rptdays nway;
  class report;
  var day;
  output out=temp1 n=ndays;
run;
************************************************************************
* 2.3 MERGE REPORT DEFINITION DATA WITH NUMBER OF DAYS IN EACH         *
*     REPORT PERIOD.                                                   *
***********************************************************************;
data rptdays;
  merge rptdays temp1(drop= _type_ _freq_);
  by report;
run;
```

```
**********************************************************************
**********************************************************************
**                                                                  **
** 3.0 INPUT TESTFISH DATA.                                         **
**                                                                  **
**********************************************************************
**********************************************************************;
**********************************************************************
* 3.1 READ TESTFISH DATA FROM ASCII FILE UNLOADED FROM RBASE.        *
**********************************************************************;
data testfish;
  infile 'd:\ydata\y97\tfish97.dat' delimiter=',';
  informat day mmddyy. startout fullout startin fullin time8.;
  input day tfperiod qlbzone$ qbank$ mesh fathoms startout fullout
        startin fullin qmethod$ refno$ captain$ spcode length sex$;

  * STRIP DATA FROM RBASE STRINGS AND CONVERT TEXT TO UPPER CASE;
  bank = upcase(substr(qbank,2,1));
  lbzone = upcase(substr(qlbzone,2,1));
  method = upcase(substr(qmethod,2,1));

  * DEFINE ZONE VARIABLE;
  if bank eq 'R' then
    zone = 1;
  else if bank eq 'L' and lbzone eq 'N' then
    zone = 2;
  else if bank = 'L' and lbzone eq 'F' then
    zone = 3;
  else
    zone = .;

  * DEFINE SEASON VARIABLE AND CORRECT ANY CHUM SPECIATION ERRORS;
  if month(day) le 6 or (month(day) eq 7 and day(day) le 18) then
    season = 'early';
  else
    season = 'late';
  if season eq 'early' and spcode eq 6 then
    spcode = 5;
  if season eq 'late' and spcode eq 5 then
    spcode = 6;

  * COMPUTE DRIFT TIME IN MINUTES AND EFFORT IN FATHOM HOURS;
  if fullout lt startout then
    do;
      t1 = startout;
      t2 = fullout + 86400;
      t3 = startin + 86400;
      t4 = fullin + 86400;
    end;
  else if startin lt fullout then
    do;
      t1 = startout;
      t2 = fullout;
      t3 = startin + 86400;
      t4 = fullin + 86400;
```

```
    end;
  else if fullin lt startin then
    do;
      t1 = startout;
      t2 = fullout;
      t3 = startin;
      t4 = fullin;
    end;
  else
    do;
      t1 = startout;
      t2 = fullout;
      t3 = startin;
      t4 = fullin;
    end;
  driftmin = (t3 + t4 - t1 - t2)/120;
  fathhrs = fathoms*driftmin/60;

  * DEFINE SPECIES NAMES;
  length species $ 8;
  if spcode eq 0 or spcode = . then
    species = 'NONE';
  else if spcode eq 1 and length ge 700 then
    species = 'CHINOOK';
  else if spcode eq 1 then
    species = 'JACK';
  else if spcode eq 3 then
    species = 'COHO';
  else if spcode eq 4 then
    species = 'PINK';
  else if spcode eq 5 then
    species = 'SCHUM';
  else if spcode eq 6 then
    species = 'FCHUM';
  else if spcode eq 7 then
    species = 'CISCO';
  else if spcode ge 8 and spcode le 9 then
    species = 'WHITE';
  else
    species = 'OTHER';

  * DEFINE VARIABLE NEEDED IN SECTION 8.1;
  _type_ = 0;

  * FORMAT VARIABLES;
  format day date7. startout time5.;
  label day='DATE';

  * DROP UNNEEDED VARIABLES;
  drop t1 t2 t3 t4 spcode fullout startin fullin qlbzone bank qbank
       qmethod refno captain sex season lbzone;
run;
***********************************************************************
* 3.2 DETERMINE MOST RECENT TESTFISH DAY AND SAVE.                    *
***********************************************************************;
proc summary data=testfish;
  var day;
```

```
  output out=maxtfday max=maxtfday;
run;
**********************************************************************
**********************************************************************
**                                                                  **
** 4.0 COMPUTE NET SELECTIVITY.                                     **
**                                                                  **
**********************************************************************
**********************************************************************;

**********************************************************************
* 4.1 READ NET SELECTIVITY PARAMETERS.                               *
**********************************************************************;
data netsel;
  infile 'd:\ydata\y97\netsel97.dat' firstobs=5;
  input species$ a b t;
run;
**********************************************************************
* 4.2 SORT DATA AND COMBINE TESTFISH DATA WITH NET SELECTIVITY       *
*     PARAMETERS.                                                    *
**********************************************************************;
proc sort data=testfish;
  by species;
run;
proc sort data=netsel;
  by species;
run;

data testfish;
  merge testfish(in=y) netsel;
  by species;
  if y;
run;
**********************************************************************
* 4.3 COMPUTE NET SELECTIVITY.                                       *
**********************************************************************;
data testfish;
  set testfish;
  if length le 0 or length eq . or mesh le 0 or mesh eq . or
      method eq 'B' then
    errcheck = 1;
  else
    do;
      lpr = length/(mesh*50.8);
      dum1 = exp(-a*(lpr-t));
    end;
  if species eq 'NONE' or errcheck eq 1 then
    select = 0;
  else
    select = ((1-b)**(1-1/b))*dum1*((1-min(1,b*dum1))**(1/b-1));
  drop lpr dum1 errcheck a b t;
run;
**********************************************************************
**********************************************************************
**                                                                  **
** 5.0 COMPUTE TRADITIONAL CPUE FOR FISHERY MANAGERS.               **
**                                                                  **
```

```
**********************************************************************
**********************************************************************;
**********************************************************************
* 5.1 ISOLATE DRIFT DATA, AND DO PRELIMINARY DATA PROCESSING.        *
**********************************************************************;
data tradcpue;
  set testfish;

  * KEEP DRIFT DATA;
  if method eq 'D';

  * COMBINE CHINOOK SIZE CLASSES;
  if species eq 'JACK' then
    species = 'CHINOOK';

  * DEFINE MESH GROUPS;
  if mesh lt 5.0 then
    delete;
  else if mesh le 6.5 then
    meshgrp = 1;
  else
    meshgrp = 2;

  * DEFINE BANK VARIABLE;
  if zone eq 1 then
    bank = 'RIGHT';
  else if zone eq 2 or zone eq 3 then
    bank = 'LEFT';
  else
    bank = '.';
  if bank ne '.';

  * DEFINE NEW VARIABLES;
  if meshgrp eq 2 and species eq 'CHINOOK' then
    chinn = 1;
  else
    chinn = 0;
  if meshgrp eq 1 and species eq 'SCHUM' then
    schumn = 1;
  else
    schumn = 0;
  if meshgrp eq 1 and species eq 'FCHUM' then
    fchumn = 1;
  else
    fchumn = 0;
  if meshgrp eq 1 and species eq 'COHO' then
    cohon = 1;
  else
    cohon = 0;

  * DROP UNNECESSARY VARIABLES;
  drop fathoms length method zone driftmin species select _type_;
run;
**********************************************************************
* 5.2 COMPUTE THE NUMBER OF FISH OF EACH SPECIES CAUGHT IN EACH      *
*     DRIFT.                                                         *
**********************************************************************;
```

```
proc summary data=tradcpue nway;
  class day bank tfperiod meshgrp mesh startout fathhrs;
  var chinn schumn fchumn cohon;
  output out=tradcpue sum(chinn)=
                      sum(schumn)=
                      sum(fchumn)=
                      sum(cohon)=;
run;
**********************************************************************
* 5.3 CREATE NEW FATHOM*HOURS VARIABLE FOR EACH MESH GROUP.          *
**********************************************************************;
data tradcpue;
  set tradcpue;
  if meshgrp eq 1 then
    fathhrss = fathhrs;
  else
    fathhrss = 0;
  if meshgrp eq 2 then
    fathhrsl = fathhrs;
  else
    fathhrsl = 0;
run;
**********************************************************************
* 5.4 SUM CATCH AND EFFORT BY DAY AND BANK.                          *
**********************************************************************;
proc summary data=tradcpue nway;
  class day bank;
  var chinn schumn fchumn cohon fathhrss fathhrsl;
  output out=tradcpue sum(chinn)=
                      sum(schumn)=
                      sum(fchumn)=
                      sum(cohon)=
                      sum(fathhrss)=
                      sum(fathhrsl)=;
run;
**********************************************************************
* 5.5 SPLIT DATA BY BANK.                                            *
**********************************************************************;
data lcpue;
  set tradcpue;
  if bank eq 'LEFT';
run;

data rcpue;
  set tradcpue;
  if bank eq 'RIGHT';
run;
**********************************************************************
* 5.6 DETERMINE THE FIRST TESTFISH DAY, COMBINE WITH THE MAXIMUM     *
*     TESTFISH DAY, AND CREATE A FILE WITH A RECORD FOR EVERY DAY.   *
**********************************************************************;
proc summary data=testfish;
  var day;
  output out=mintfday min=mintfday;
run;

data daylist;
```

Appendix B. (Continued)

```
  merge mintfday maxtfday;
  do day = mintfday to maxtfday;
    output;
  end;
  drop _type_ _freq_ mintfday maxtfday;
run;
*****************************************************************
* 5.7 MERGE FILES BY BANK WITH THE FILE WITH A RECORD FOR EVERY DAY. *
*****************************************************************;
data lcpue;
  merge lcpue daylist;
  by day;
run;

data rcpue;
  merge rcpue daylist;
  by day;
run;
*****************************************************************
* 5.8 SET MISSING VALUES TO ZERO AND COMPUTE CPUE.                *
*****************************************************************;
data lcpue;
  set lcpue;

  * SET MISSING VALUES TO ZERO;
  if chinn eq . then
    chinn = 0;
  if schumn eq . then
    schumn = 0;
  if fchumn eq . then
    fchumn = 0;
  if cohon eq . then
    cohon = 0;
  if fathhrss eq . then
    fathhrss = 0;
  if fathhrsl eq . then
    fathhrsl = 0;

  * COMPUTE CPUE;
  if fathhrsl gt 0 then
    chinc = round(chinn/fathhrsl, 0.01);
  else
    chinc = 0;
  if fathhrss gt 0 then
    do;
      schumc = round(schumn/fathhrss, 0.01);
      fchumc = round(fchumn/fathhrss, 0.01);
      cohoc = round(cohon/fathhrss, 0.01);
    end;
  else
    do;
      schumc = 0;
      fchumc = 0;
      cohoc = 0;
    end;

  * FORMAT VARIABLES FOR OUTPUT;
```

Appendix B. (Continued)

```
  format chinc schumc fchumc cohoc fathhrss fathhrsl 6.2;
  label fathhrss ='SMALL MESH FATHOM HOURS'
        chinn = 'CHINOOK CATCH'
        chinc = 'CHINOOK CPUE'
        fathhrsl = 'LARGE MESH FATHOM HOURS'
        schumn = 'SUMMER CHUM CATCH'
        schumc = 'SUMMER CHUM CPUE'
        fchumn = 'FALL CHUM CATCH'
        fchumc = 'FALL CHUM CPUE'
        cohon = 'COHO CATCH'
        cohoc = 'COHO CPUE';
run;

data rcpue;
  set rcpue;

 * SET MISSING VALUES TO ZERO;
  if chinn eq . then
    chinn = 0;
  if schumn eq . then
    schumn = 0;
  if fchumn eq . then
    fchumn = 0;
  if cohon eq . then
    cohon = 0;
  if fathhrss eq . then
    fathhrss = 0;
  if fathhrsl eq . then
    fathhrsl = 0;

  * COMPUTE CPUE;
  if fathhrsl gt 0 then
    chinc = round(chinn/fathhrsl, 0.01);
  else
    chinc = 0;
  if fathhrss gt 0 then
    do;
      schumc = round(schumn/fathhrss, 0.01);
      fchumc = round(fchumn/fathhrss, 0.01);
      cohoc = round(cohon/fathhrss, 0.01);
    end;
  else
    do;
      schumc = 0;
      fchumc = 0;
      cohoc = 0;
    end;

  * FORMAT VARIABLES FOR OUTPUT;
  format chinc schumc fchumc cohoc fathhrss fathhrsl 6.2;
  label fathhrss ='SMALL MESH FATHOM HOURS'
        chinn = 'CHINOOK CATCH'
        chinc = 'CHINOOK CPUE'
        fathhrsl = 'LARGE MESH FATHOM HOURS'
        schumn = 'SUMMER CHUM CATCH'
        schumc = 'SUMMER CHUM CPUE'
        fchumn = 'FALL CHUM CATCH'
```

```
        fchumc = 'FALL CHUM CPUE'
        cohon = 'COHO CATCH'
        cohoc = 'COHO CPUE';
run;

*********************************************************************
* 5.9 PRINT CPUE INFORMATION.                                       *
*********************************************************************;
title2 'LEFT BANK CPUE IN FATHOM*HOURS';
title3 'Small meshes: 5.0, 5.5, 6.5';
title4 'Large Meshes: 7.5, 8.5';
proc print data=lcpue label;
  var day fathhrsl chinn chinc fathhrss schumn schumc fchumn fchumc
      cohon cohoc;
  sum chinc schumc fchumc cohoc;
run;

title2 'RIGHT BANK CPUE IN FATHOM*HOURS';
title3 'Small meshes: 5.0, 5.5, 6.5';
title4 'Large Meshes: 7.5, 8.5';
proc print data=rcpue label;
  var day fathhrsl chinn chinc fathhrss schumn schumc fchumn fchumc
      cohon cohoc;
  sum chinc schumc fchumc cohoc;
run;
*********************************************************************
*********************************************************************
**                                                                 **
** 6.0 PRINT SUMMARY TESTFISH RESULTS FOR MOST RECENT DAY.         **
**                                                                 **
*********************************************************************
*********************************************************************;

*********************************************************************
* 6.1 MERGE TESTFISH DATA WITH LAST TESTFISH DAY, AND DISCARD ALL   *
*     BUT MOST RECENT DAY'S DATA.                                   *
*                                                                   *
*     NOTE: TO OBTAIN MORE THAN 1 DAY'S DATA, CHANGE THE ZERO IN THE *
*           IF STATEMENT TO A LARGER NUMBER.                        *
*********************************************************************;
data tfrecnt;
  merge testfish maxtfday;
  by _type_;
  if day ge maxtfday - 0;
  drop maxtfday _type_ _freq_;
run;
*********************************************************************
* 6.2 COMPUTE THE NUMBER OF FISH OF EACH SPECIES CAUGHT IN EACH     *
*     DRIFT.                                                        *
*********************************************************************;
proc summary data=tfrecnt nway;
  class day tfperiod mesh startout zone method species;
  id fathoms driftmin fathhrs;
  var length;
  output out=tfrecnt n=ncatch;
run;
*********************************************************************
```

```
* 6.3 TRANSPOSE DATA TO GET ONE LINE PER DRIFT, EACH SPECIES IN A     *
*     SEPARATE VARIABLE.                                              *
***********************************************************************;
proc transpose data=tfrecnt out=tfrecntw;
  var ncatch;
  id species;
  by day tfperiod mesh startout zone method fathoms driftmin;
run;
***********************************************************************
* 6.4 CREATE DUMMY DATASET CONTAINING ALL SPECIES.  IN SUBSEQUENT     *
*     PRINTS THIS ENSURES ALL SPECIES ARE LISTED, EVEN IF NON WERE    *
*     CAUGHT.                                                         *
***********************************************************************;
data spplist;
  chinook = 0;
  jack = 0;
  schum = 0;
  fchum = 0;
  coho = 0;
  pink = 0;
  white = 0;
  cisco = 0;
  other=0;
run;
***********************************************************************
* 6.5 MERGE TESTFISH DRIFT DATA WITH SPECIES LIST.                    *
***********************************************************************;
data tfrecntw;
  set tfrecntw(in=a drop=_name_) spplist;
  if a;
run;
***********************************************************************
* 6.6 TRANSPOSE DATA BACK TO GET NUMBER CAUGHT INTO A SINGLE COLUMN.  *
***********************************************************************;
proc transpose data=tfrecntw name=species out=temp1;
  var chinook jack schum pink fchum coho white cisco other;
  by day tfperiod mesh startout zone method fathoms driftmin;
run;
***********************************************************************
* 6.7 SET MISSING VALUES TO 0.                                        *
***********************************************************************;
data temp1;
  set temp1;
  if col1 eq . then
    col1 = 0;
  rename col1 = ncatch;
run;
***********************************************************************
* 6.8 COMPUTE NUMBER OF FISH CAUGHT IN EACH DRIFT.                    *
***********************************************************************;
proc summary data=temp1 nway;
  class day tfperiod mesh startout zone method fathoms driftmin;
  var ncatch;
  output out=temp2 sum(ncatch)=sumcatch;
run;
***********************************************************************
* 6.9 TRANSPOSE DATA TO GET ONE LINE PER DRIFT, EACH SPECIES IN A     *
```

```
*     SEPARATE VARIABLE.                                              *
**********************************************************************;
proc transpose data=temp1 out=tfrecntw;
  var ncatch;
  id species;
  by day tfperiod mesh startout zone method fathoms driftmin; .
run;
**********************************************************************
* 6.10 MERGE CATCH BY SPECIES WITH TOTAL CATCH.                      *
**********************************************************************;
data tfrecntw;

  * MERGE DATA;
  merge tfrecntw(drop=_name_) temp2(drop= _type_ _freq_);
  by day tfperiod mesh startout zone method fathoms driftmin;

  * FORMAT VARIABLES FOR OUTPUT;
  format driftmin 6.2;
  label driftmin = 'FISHING TIME: MINUTES'
        chinook = 'CHINOOK >=700mm'
        jack = 'CHINOOK <700mm'
        schum = 'SUMMER CHUM'
        fchum = 'FALL CHUM'
        white = 'WHITEFISH'
        cisco = 'CISCO SPECIES'
        other = 'OTHER SPECIES'
        startout = 'TIME DRIFT BEGAN'
        tfperiod = 'TESTFISH PERIOD'
        sumcatch = 'TOTAL CATCH';
run;
**********************************************************************
* 6.11 PRINT TESTFISH HARVESTS ON MOST RECENT DAY, BY DRIFT.         *
**********************************************************************;
title2 'SUMMARY OF MOST RECENT TESTFISH HARVESTS - BY DRIFT';
proc print data=tfrecntw noobs label;
  var day tfperiod mesh startout zone method;
  sum driftmin chinook jack schum fchum coho pink white cisco other
      sumcatch;
run;
**********************************************************************
* 6.12.1 OPTIONAL                                                    *
*                                                                    *
*          COMPUTE TESTFISH CPUE ON MOST RECENT DAY, BY DRIFT.       *
**********************************************************************;
data cpuercnt;
  set tfrecntw;
  effort = fathoms*driftmin/60;
  chinook = round(chinook/effort, 0.01);
  jack = round(jack/effort, 0.01);
  schum = round(schum/effort, 0.01);
  fchum = round(fchum/effort, 0.01);
  coho = round(coho/effort, 0.01);
  pink = round(pink/effort, 0.01);
  white = round(white/effort, 0.01);
  cisco = round(cisco/effort, 0.01);
  other = round(other/effort, 0.01);
  sumcpue = chinook + jack + schum + fchum + coho + pink + white +
```

```
             cisco + other;
  drop effort sumcatch;
run;
*****************************************************************************
* 6.12.2 PRINT TESTFISH CPUE ON MOST RECENT DAY, BY DRIFT.                  *
*****************************************************************************;
title2 'SUMMARY OF MOST RECENT TESTFISH CPUE - BY DRIFT';
title3 'CPUE IS REPORTED IN UNITS OF CATCH PER FATHOM*HOUR';
title4 'OPTIONAL OUTPUT';
proc print data=cpuercnt noobs label;
  format chinook jack schum fchum coho pink white cisco other
         sumcpue 6.2;
  var day tfperiod mesh startout zone method;
  sum driftmin chinook jack schum fchum coho pink white cisco other
      sumcpue;
run;
*****************************************************************************
*****************************************************************************
**                                                                         **
** 7.0 PROCESS TESTFISH DATA.                                              **
**                                                                         **
*****************************************************************************
*****************************************************************************;

*****************************************************************************
* 7.1 DISCARD BEACHWALK DATA AND COMPUTE ADJUSTED CATCH.                    *
*****************************************************************************;
data tfadjcat;
  set testfish;

  * DISCARD BEACHWALK DATA;
  if method eq 'D';

  * COMPUTE ADJUSTED CATCH;
  catch = 1;
  if select ge 0.10 then
    adjcat = catch/select;
  else
    adjcat = 0;

  _type_ = 0;
run;
*****************************************************************************
* 7.2.0 OPTIONAL                                                            *
*                                                                           *
*       PRINT DETAILS OF EACH FISH CAUGHT ON MOST RECENT DAY.               *
*****************************************************************************;
*****************************************************************************
* 7.2.1  RESTRICT ATTENTION TO ADJUSTED CATCH DATA FOR FISH CAUGHT          *
*        ON MOST RECENT DAY.                                                *
*****************************************************************************;
data tfrecnt2;
  merge tfadjcat maxtfday;
  by _type_;

  * RESTRICT DATA TO FISH CAUGHT ON MOST RECENT DAY;
  if day ge maxtfday - 0;
```

```
  if species ne 'NONE';

  * PREPARE VARIABLES FOR OUTPUT;
  format catch adjcat 7.3
         driftmin 5.2;
  label tfperiod = 'TESTFISH PERIOD'
        startout = 'TIME DRIFT BEGAN'
        driftmin = 'FISHING TIME: MINUTES'
        select = 'NET SELECTIVITY'
        adjcat = 'ADJUSTED CATCH';

  * DROP UNNEEDED VARIABLES;
  drop method fathhrs fathoms maxtfday _type_ _freq_;
run;
***********************************************************************
* 7.2.2 PRINT DETAILS OF EACH FISH CAUGHT ON MOST RECENT DAY, BY     *
*       DRIFT.                                                        *
***********************************************************************;
proc sort data=tfrecnt2;
  by day tfperiod mesh startout zone driftmin species length select;
run;

title2 'DETAILS OF FISH CAUGHT ON MOST RECENT DAY';
title3 'EXCLUDES FISH CAUGHT DURING BEACHWALKS';
title4 'OPTIONAL OUTPUT';
proc print data=tfrecnt2 noobs label;
  var day tfperiod mesh startout zone driftmin species length select
      catch adjcat;
  sum catch adjcat;
run;
***********************************************************************
* 7.3  COMBINE CISCO AND WHITEFISH WITH OTHERS.                       *
***********************************************************************;
data tfadjcat;
  set tfadjcat;
  if species eq 'CISCO' or species eq 'WHITE' then
    species = 'OTHER';
run;
***********************************************************************
* 7.4 SUM ADJUSTED CATCH WITHIN THE SAME DAY, ZONE, TESTFISH PERIOD, *
*     MESH, SPECIES, AND LENGTH.                                      *
***********************************************************************;
proc summary data=tfadjcat nway;
  class day zone tfperiod mesh species length;
  var catch adjcat;
  output out=dbpslcat sum(catch)=rawcatch
                      sum(adjcat)=dbpslcat;
run;
***********************************************************************
* 7.5 ISOLATE UNIQUE DRIFTS.                                          *
***********************************************************************;
proc summary data=tfadjcat nway;
  class day zone tfperiod mesh startout;
  var fathhrs;
  output out=temp min=;
run;
***********************************************************************
```

```
* 7.6 SUM EFFORT FOR ALL DRIFTS WITH THE SAME MESH BY DAY, ZONE,      *
*     AND TESTFISH PERIOD.                                            *
***********************************************************************;
proc summary data=temp nway;
  class day zone tfperiod mesh;
  var fathhrs;
  output out=effort sum=meffort;
run;
***********************************************************************
* 7.7 MERGE CATCH AND EFFORT DATA, DROPPING ADJUSTED CATCHES LESS     *
*     THAN 0, AND COMPUTE CPUE.                                       *
***********************************************************************;
data cpue;
  merge dbpslcat effort;
  by day zone tfperiod mesh;
  if dbpslcat gt 0;

  * COMPUTE CPUE;
  cpue = dbpslcat/meffort;

  * DROP UNNEEDED VARIABLES AND ROWS;
  drop dbpslcat meffort _type_ _freq_;
  if species eq 'NONE' then
    delete;
run;
***********************************************************************
* 7.8 COMPUTE MEAN CPUE OVER MESH SIZES WITHIN DAY, ZONE, TESTFISH    *
*     PERIOD, SPECIES, AND LENGTH.                                    *
***********************************************************************;
proc summary data=cpue nway;
  class day zone tfperiod species length;
  var cpue rawcatch;
  output out=meancpue mean(cpue)=
                      sum(rawcatch)=;
run;
***********************************************************************
* 7.9 SUM MEAN CPUE OVER LENGTH FOR EACH DAY, ZONE, TESTFISH PERIOD   *
*     AND SPECIES.                                                    *
***********************************************************************;
proc summary data=meancpue nway;
  class day zone tfperiod species;
  var cpue rawcatch;
  output out=spcpue sum(cpue)=
                    sum(rawcatch)=;
run;
***********************************************************************
* 7.10 SUM CPUE OVER SPECIES FOR EACH DAY, ZONE, AND TESTISH PERIOD.  *
***********************************************************************;
proc summary data=spcpue nway;
  class day zone tfperiod;
  var cpue rawcatch;
  output out=tfpcpue sum(cpue)=tfpcpue
                     sum(rawcatch)=tfprcat;
run;
***********************************************************************
* 7.11 TRANSPOSE SPECIES CPUE DATA, WHICH CREATES A SEPARATE CPUE     *
*      VARIABLE FOR EACH SPECIES.                                     *
```

```
*************************************************************************;
proc transpose data=spcpue out=spcpuew;
  by day zone tfperiod;
  id species;
  var cpue;
run;
*************************************************************************
* 7.12 MERGE SPECIES CPUE WITH TOTAL CPUE FOR ALL SPECIES WITHIN A      *
*      TESTFISH PERIOD, AND SET MISSING VALUES TO ZERO. THIS            *
*      OPERATION ALSO CREATES A VARIABLE FOR EACH SPECIES, EVEN IF      *
*      NONE HAVE BEEN CAUGHT.                                           *
*************************************************************************;
data spcpuew;
  merge spcpuew(drop= _name_) tfpcpue(drop= _type_ _freq_);
  by day zone tfperiod;
  if jack eq . then
    jack = 0;
  if chinook eq . then
    chinook = 0;
  if schum eq . then
    schum = 0;
  if fchum eq . then
    fchum = 0;
  if coho eq . then
    coho = 0;
  if pink eq . then
    pink = 0;
  if other eq . then
    other = 0;
  if tfpcpue eq . then
    tfpcpue = 0;
  if tfprcat eq . then
    tfprcat = 0;
run;
*************************************************************************
* 7.13 TRANSPOSE DATA BACK TO GET SPECIES CPUE IN SINGLE VARIABLE.      *
*************************************************************************;
proc transpose data=spcpuew out=spcpue
               name=species;
  by day zone tfperiod tfpcpue tfprcat;
run;
*************************************************************************
* 7.14 COMPUTE SPECIES PROPORTIONS FOR EACH TESTFISH PERIOD.            *
*************************************************************************;
data spcpue;
  set spcpue;
  cpue=col1;
  if tfpcpue gt 0 then
    tfpprop = cpue/tfpcpue;
  else
    tfpprop = 0;
  drop col1;
run;
*************************************************************************
* 7.15 OPTIONAL                                                         *
*                                                                       *
*      PLOT MEAN CPUE, ACROSS TESTFISH PERIODS WITHIN A DAY, BY         *
```

```
*      ZONE AND SPECIES.                                                *
*************************************************************************;
proc sort data=spcpue;
  by zone;
run;

title2 'MEAN TESTFISH PERIOD CPUE - BY DAY';
title3 'OPTIONAL OUTPUT';
proc chart data=spcpue;
  by zone;
  vbar day / type=mean sumvar=cpue subgroup=species discrete;
run;
*************************************************************************
* 7.16 ASSIGN REPORT PERIOD DESIGNATIONS TO DAYS.                       *
*************************************************************************;
proc sort data=spcpue;
  by day;
run;

proc sort data=rptdays;
  by day;
run;

data spcpue;
  merge rptdays(keep= report day) spcpue(in=a);
  by day;
  if a;
run;
*************************************************************************
* 7.17.0 ESTIMATE VARIANCE OF SPECIES PROPORTIONS.                      *
*************************************************************************;
*************************************************************************
* 7.17.1 ISOLATE TOTAL CPUE BY TESTFISH PERIOD.                         *
*************************************************************************;
proc summary data=spcpue nway;
  class report day zone tfperiod;
  var tfpcpue;
  output out=temp min=;
run;
*************************************************************************
* 7.17.2 COMPUTE MEAN TOTAL CPUE OVER ALL TESTFISH PERIODS IN EACH      *
*        REPORT PERIOD, BY ZONE.                                        *
*************************************************************************;
proc summary data=temp nway;
  class report zone;
  id day;
  var tfpcpue;
  output out=temp mean=mtfpcpue;
run;
*************************************************************************
* 7.17.3 MERGE MEAN TOTAL CPUE WITH OTHER TESTFISH PERIOD CPUE DATA.    *
*************************************************************************;
proc sort data=spcpue;
  by report zone species;
run;

data spcpue;
```

```
  merge spcpue(in=a) temp(keep=report zone mtfpcpue);
  by report zone;
  if a;
run;
**********************************************************************
* 7.17.4 SUM CPUE OVER TESTFISH PERIODS BY REPORT PERIOD, BANK, AND  *
*        SPECIES.                                                    *
**********************************************************************;
proc summary data=spcpue nway;
  class report zone species;
  var cpue tfprcat;
  output out=rptcpue sum(cpue)=rptcpue
                     sum(tfprcat)=rptrcat
                     n=ntfp;
run;
**********************************************************************
* 7.17.5 SUM CPUE OVER SPECIES BY REPORT PERIOD AND ZONE.            *
**********************************************************************;
proc summary data=rptcpue nway;
  class report zone;
  var rptcpue rptrcat;
  output out=temp sum(rptcpue)=rptscpue
                  min(rptrcat)=;
run;
**********************************************************************
* 7.17.6 MERGE REPORT PERIOD SPECIES CPUE WITH REPORT PERIOD TOTAL   *
*        CPUE AND COMPUTE SPECIES PROPORTIONS FOR EACH REPORT        *
*        PERIOD.                                                     *
**********************************************************************;
data rptcpue;
  merge rptcpue(in=a) temp(keep=report zone rptscpue rptrcat);
  by report zone;
  if a;
  if rptscpue gt 0 then
    rptprop = rptcpue/rptscpue;
  else
    rptprop = 0;
run;
**********************************************************************
* 7.17.7 MERGE TESTFISH PERIOD AND REPORT PERIOD ESTIMATES OF        *
*        SPECIES PROPORTIONS AND COMPUTE COMPONENTS OF REPORT        *
*        PERIOD SPECIES PROPORTION VARIANCES.                        *
**********************************************************************;
data spprop;
  merge spcpue(in=a drop=tfprcat cpue)
        rptcpue(drop= _type_ _freq_ rptcpue rptscpue);
  by report zone species;
  if a;

  if mtfpcpue eq 0 or ntfp le 1 then
    propvar1 = 0;
  else
    propvar1 = ((tfpcpue*(tfpprop-rptprop)/mtfpcpue)**2)/(ntfp-1);
run;
**********************************************************************
* 7.17.8 COMPUTE ESTIMATES OF VARIANCE OF SPECIES PROPORTION         *
*        ESTIMATES.                                                  *
```

```
*********************************************************************;
proc summary data=spprop nway;
  class report zone species;
  var propvar1;
  output out=temp mean=propvar;
run;
*********************************************************************
* 7.17.9 MERGE VARIANCE ESTIMATE WITH SPECIES PROPORTION ESTIMATES.  *
*********************************************************************;
data spprop;
  merge spprop(in=a drop=tfperiod tfpcpue tfpprop mtfpcpue propvar1)
        temp(keep=report zone species propvar);
  by report zone species;
  if a;
run;
*********************************************************************
* 7.17.10 ISOLATE SPECIES PROPORTIONS DATA FOR EACH REPORT PERIOD,   *
*         DAY, AND ZONE.                                             *
*********************************************************************;
proc summary data=spprop nway;
  class report day zone species;
  id propvar rptrcat ntfp;
  var rptprop day;
  output out=spprop min(rptprop)=;
run;
*********************************************************************
* 7.18.0 PRINT SPECIES PROPORTIONS BY REPORT PERIOD AND ZONE.        *
*********************************************************************;
*********************************************************************
* 7.18.1 ISOLATE SPECIES PROPORTIONS DATA FOR EACH REPORT PERIOD     *
*        AND ZONE.                                                   *
*********************************************************************;
proc summary data=spprop nway;
  class report zone species;
  id rptrcat ntfp;
  var rptprop day;
  output out=rptprop min(rptprop)=
                     min(day)=fday
                     max(day)=lday;
run;
*********************************************************************
* 7.18.2 TRANSPOSE DATA TO GET A VARIABLE FOR EACH SPECIES.          *
*********************************************************************;
proc transpose data=rptprop out=rptpropw;
  by report fday lday zone rptrcat ntfp;
  id species;
  var rptprop;
run;
*********************************************************************
* 7.18.3 PRINT REPORT PERIOD SPECIES PROPORTIONS DATA.               *
*********************************************************************;
title2 'SPECIES PROPORTIONS BY REPORT PERIOD AND ZONE';
proc print data=rptpropw noobs label;
  label report = 'REPORT NUMBER'
        fday = 'FIRST DAY'
        lday = 'LAST DAY'
        ntfp = 'NUMBER TESTFISH PERIODS'
```

Appendix B. (Continued)

```
        rptrcat = 'NUMBER FISH CAUGHT'
        schum='SUMMER CHUM'
        fchum='FALL CHUM'
        other='NON-SALMON';
  format chinook jack schum pink fchum coho other 6.4
         fday lday date7.;
  var report fday lday zone ntfp rptrcat chinook jack schum pink fchum
      coho other;
run;
*************************************************************************
*************************************************************************
**                                                                     **
** 8.0 INPUT SONAR DATA AND CONSTRUCT BASIC DATA SETS.                 **
**                                                                     **
*************************************************************************
*************************************************************************;
*************************************************************************
* 8.1 READ SONAR DATA FROM ASCII FILE UNLOADED FROM RBASE DATABASE.    *
*************************************************************************;
data sonarct;
  infile 'd:\ydata\y97\sonar97.dat' delimiter=',';
  informat day mmddyy8. startime endtime time8.;
  input day speriod stratum startime endtime sector secwidth strtrang
        upcount dwncount operator$ minutes;

  * DEFINE ZONE VARIABLE BASED ON STRATA;
  if stratum le 2 then
    zone = 1;
  else if stratum eq 3 then
    zone = 2;
  else if stratum gt 3 then
    zone = 3;
  else
    delete;

  * COMPUTE DURATION OF COUNTS IN HOURS, ADJUSTING FOR COUNTING TIMES
  WHICH SPAN MIDNIGHT;
  counthrs = (endtime - startime)/3600;
  if counthrs lt 0 then
    counthrs = counthrs + 24;

  * DEFINE VARIABLE NEEDED IN SECTION 4.1;
  _type_ = 0;

  * FORMAT VARIABLES;
  format day date7. startime endtime time5.;
  label day='DATE';

  * DROP UNNEEDED VARIABLES;
  drop operator minutes;
run;
*************************************************************************
* 8.2 DETERMINE 24 HOUR COUNT DAYS.                                     *
*************************************************************************;
proc summary data=sonarct nway;
  class day;
  var speriod;
```

```
  output out=days24 min=;
run;

data days24;
  set days24;
  if speriod eq 0;
  drop _type_ _freq_ speriod;
run;
*************************************************************************
* 8.3 CONSTRUCT DATA SET CONSISTING ONLY OF DATA FROM 24 HOUR COUNT    *
*     DAYS.                                                             *
*************************************************************************;
proc sort data=sonarct;
  by day;
run;

proc sort data=days24;
  by day;
run;

data sonar24;
  merge sonarct days24(in=a);
  by day;
  if a;
run;

*************************************************************************
* 8.4 CONSTRUCT DATA SET CONSISTING ONLY OF DATA COLLECTED DURING       *
*     THE NORMAL SONAR PERIODS.                                         *
*************************************************************************;
data sonarct;
  set sonarct;
  if speriod ge 1 and speriod le 3;
run;
*************************************************************************
* 8.5 DETERMINE MOST RECENT DAY IN SONAR DATA AND SAVE.                 *
*************************************************************************;
proc summary data=sonarct;
  var day;
  output out=maxsday max=maxsday;
run;
*************************************************************************
*************************************************************************
**                                                                     **
** 9.0 PLOT UPSTREAM TARGETS PER HOUR FOR EACH BANK AND SONAR          **
**     PERIOD ON THE MOST RECENT DAY.                                  **
**                                                                     **
*************************************************************************
*************************************************************************;

*************************************************************************
* 9.1 COMPUTE UPSTREAM TARGETS PER METER OF RANGE DURING EACH PERIOD   *
*     FOR THE MOST RECENT DAY.                                          *
*************************************************************************;
data rangdist;
  merge sonarct maxsday;
  by _type_;
```

```
  * ONLY KEEP DATA FROM MOST RECENT DAY;
  if day eq maxsday;

  * DEFINE BANK VARIABLE;
  if zone eq 1 then
    bank = 'RIGHT';
  else if zone eq 2 or zone eq 3 then
    bank = 'LEFT';
  if bank eq 'RIGHT' or bank eq 'LEFT';

  * COMPUTE STARTING AND ENDING RANGE OF EACH STRATUM;
  range1 = round(strtrang+(sector-1)*secwidth,1);
  range2 = round(strtrang+sector*secwidth,1);

  * COMPUTE NUMBER OF TARGETS PER METER PER HOUR;
  upcntpm = upcount/secwidth;

  * INSERT ROW IN DATASET FOR EACH 1 METER RANGE INTERVAL, AND DEFINE
    MIDPOINT OF RANGE INTERVAL;
  binsize = 10;
  do range = range1 to (range2-1);
    rangebin = range - mod(range,binsize) + binsize/2;
    output;
  end;
run;

**********************************************************************
* 9.2 SUM TARGETS PER METER AND COUNTING TIME OVER UNIQUE STARTING   *
*     TIMES FOR EACH METER OF RANGE AND EACH SONAR PERIOD.           *
**********************************************************************;
proc summary data=rangdist nway;
  class day bank speriod rangebin range;
  var upcntpm counthrs;
  output out=passrate sum(upcntpm)=
                      sum(counthrs)=;
run;
**********************************************************************
* 9.3 CALCULATE UPSTREAM PASSAGE RATE PER HOUR PER METER.            *
**********************************************************************;
data passrate;
  set passrate (drop= _type_ _freq_);

  * CALCULATE PASSAGE RATE;
  psperbin = upcntpm/counthrs;
  label psperbin = 'TARGETS PER HOUR:'
        rangebin = 'RANGE (METERS)';
run;
**********************************************************************
* 9.4 SUM HOURLY PASSAGE RATES ACROSS RANGE WITHIN RANGEBINS.        *
**********************************************************************;
proc summary data=passrate nway;
  class day bank speriod rangebin;
  var psperbin;
  output out=passrate sum(psperbin)=;
run;
**********************************************************************
```

```
* 9.5 CHART DISTRIBUTION OF UPSTREAM PASSAGE RATE BY BANK AND SONAR  *
*     PERIOD.                                                        *
*********************************************************************;
title2 'UPSTREAM PASSAGE RATE (TARGETS PER HOUR) AT RANGE';
title3 'BY BANK AND SONAR PERIOD';
proc chart data=passrate;
  by day bank speriod;
  vbar rangebin / sumvar=psperbin discrete;
run;
*********************************************************************
*********************************************************************
**                                                                 **
** 10.0 PROCESS SONAR DATA.                                        **
**                                                                 **
*********************************************************************
*********************************************************************;
*********************************************************************
* 10.1 SUM UPSTREAM COUNTS ACROSS SECTORS.                          *
*********************************************************************;
proc summary data=sonarct nway;
  class day speriod zone stratum startime;
  id endtime counthrs;
  var upcount;
  output out=sumsctrs sum=;
run;
*********************************************************************
* 10.2.0 COMPUTE INTERMEDIATE QUANTITIES NECESSARY TO DETERMINE THE  *
*        DURATION OF SONAR PERIODS, THIS IS NECESSITATED BY SONAR    *
*        PERIODS EXTENDING PAST MIDNIGHT.                            *
*********************************************************************;
*********************************************************************
* 10.2.1 CREATE NEW STARTING AND ENDING TIME VARIABLES, ADJUSTING    *
*        FOR SAMPLING INTERVALS WHICH EXTEND PAST MIDNIGHT.          *
*********************************************************************;
data sumsctrs;
  set sumsctrs (drop = _type_ _freq_);

  * DEFINE newend TO EQUAL endtime UNLESS endtime EQUALS MIDNIGHT;
  if endtime eq 0 then
    newend = 86400;
  else
    newend = endtime;

  * DEFINE newstart TO EQUAL startime UNLESS SAMPLING INTERVAL EXTENDS
    ACROSS MIDNIGHT, IN WHICH CASE THE INTERVAL IS SHIFTED TO START AT
    TIME 0;
  newstart = startime;
  if startime gt newend then do
    newstart = 0;
    newend = newend + (86400 - startime);
  end;

  * SPLIT SONAR PERIODS CONTAINING MIDNIGHT INTO TWO;
  if newstart le 43200 then
    s1 = newstart;
  else
    s2 = newstart;
```

```
  if newend le 43200 then
    e1 = newend;
  else
    e2 = newend;
  format startime time5.;
  drop newstart newend;
run;
*************************************************************************
* 10.2.2 COMPUTE MINIMUM AND MAXIMUM VALUES OF NEW TIME VARIABLES.     *
*************************************************************************;
proc summary data=sumsctrs nway;
  class day speriod zone stratum;
  var s1 s2 e1 e2;
  output out=temp1 min(s1) = mins1
                   max(e1) = maxe1
                   min(s2) = mins2
                   max(e2) = maxe2;
run;
*************************************************************************
* 10.2.3 MERGE DATA WITH INTERMEDIATE TIME STATISTICS.                  *
*************************************************************************;
data sumsctrs;
  merge sumsctrs(in=a) temp1(drop = _type_ _freq_);
  by day speriod zone stratum;
  if a;
  drop endtime s1 s2 e1 e2;
run;
*************************************************************************
* 10.3 SUM UPSTREAM COUNT AND COUNTING TIME ACROSS ALL SAMPLE TIMES    *
*      WITHIN A SONAR PERIOD AND STRATUM.                               *
*************************************************************************;
proc summary data=sumsctrs nway;
  class day speriod zone stratum;
  var upcount counthrs startime mins1 mins2 maxe1 maxe2;
  output out=strathpr n(upcount)=ncounts
                      sum(upcount)=
                      sum(counthrs)=
                      min(startime)=
                      min(mins1)=
                      min(mins2)=
                      max(maxe1)=
                      max(maxe2)=;
run;
*************************************************************************
* 10.4 MERGE DATA WITH REPORT PERIOD DEFINITIONS AND COMPUTE HOURLY    *
*      PASSAGE RATE WITHIN STRATA.                                      *
*************************************************************************;
data strathpr;
  merge strathpr(in=a) rptdays(keep=report day);
  by day;
  if a;
  strathpr = upcount/counthrs;
  format strathpr 7.1;
  drop _type_ _freq_;
run;
*************************************************************************
* 10.5.0 OPTIONAL                                                       *
```

```
*                                                                   *
*        TRANSPOSE AND PRINT STRATUM MEANS DATA IN A FORMAT WHICH   *
*        FACILITATES INTERPOLATION.  THIS MAY BE NEEDED TO ESTIMATE *
*        COUNTS IN MISSED SONAR PERIODS.                            *
*********************************************************************;

*********************************************************************
* 10.5.1 TRANSPOSE HOURLY PASSAGE RATE DATA TO GET ONE VARIABLE FOR *
*        EACH STRATUM.                                              *
*********************************************************************;
proc transpose data=strathpr out=strahprw;
  by report day speriod;
  var strathpr;
  id stratum;
run;
*********************************************************************
* 10.5.2 FORMAT DATASET FOR OUTPUT.                                 *
*********************************************************************;
data strahprw;
  set strahprw (drop= _name_);
  format _1-_5 8.1;
  label _1='1: RIGHT BANK #1'
        _2='2: RIGHT BANK #2'
        _3='3: LEFT BANK NEARSHORE'
        _4='4: LEFT BANK MIDSHORE'
        _5='5: LEFT BANK OFFSHORE'
        speriod = 'SONAR PERIOD';
run;
*********************************************************************
* 10.5.3 PRINT HOURLY PASSAGE RATES                                 *
*********************************************************************;
title2 'HOURLY PASSAGE RATE BY STRATUM';
title3 'USED FOR ESTIMATING COUNTS IN MISSED SONAR PERIODS';
title4 'OPTIONAL OUPUT';
proc print data=strahprw label noobs;
  var report day speriod _1 _2 _3 _4 _5;
run;
*********************************************************************
* 10.6 SUM HOURLY PASSAGE RATES ACROSS STRATA WITHIN EACH ZONE AND  *
*      SONAR PERIOD.                                                *
*********************************************************************;
proc summary data=strathpr nway;
  class zone report day speriod;
  var strathpr startime mins1 mins2 maxe1 maxe2;
  output out=perhpr sum(strathpr)=perhpr
                    min(startime)=
                    min(mins1)=
                    min(mins2)=
                    max(maxe1)=
                    max(maxe2)=;
run;
*********************************************************************
* 10.7 COMPUTE DURATION OF SONAR PERIODS AND REDEFINE startime WHERE *
*      NECESSARY.                                                   *
*********************************************************************;
data perhpr;
  set perhpr;
```

```
  * COMPUTE TIME FROM FIRST TO LAST SAMPLE WITHIN EACH
    SONAR PERIOD;
  if mins1 eq "." and maxe1 eq "." then
    hoursdur = (maxe2 - mins2)/3600;
  else if mins2 eq "." and maxe2 eq "." then
    hoursdur = (maxe1 - mins1)/3600;
  else
    hoursdur = (maxe1 + 86400 - mins2)/3600;

  * REDEFINE startime WHERE NECESSARY;
  if mins1 ne "." and mins2 ne "." then
    startime = mins2;

  * DROP UNNEEDED VARIABLES;
  drop _type_ _freq_ mins1 mins2 maxe1 maxe2;
run;
**********************************************************************
* 10.8.0: OPTIONAL                                                   *
*                                                                    *
*         PLOT SONAR PERIOD HOURLY PASSAGE RATES OVER TIME.          *
**********************************************************************;
**********************************************************************
* 10.8.1 FORMAT DATASET FOR OUTPUT.                                  *
**********************************************************************;
data hprplot;
  set perhpr;
  datetime=dhms(day,hour(startime),minute(startime),second(startime));
  label datetime='STARTING TIME OF SONAR PERIOD'
        perhpr='HOURLY PASSAGE RATE';
  format datetime datetime7.;
run;
**********************************************************************
* 10.8.2 PLOT SONAR PERIOD HOURLY PASSAGE RATES.                     *
**********************************************************************;
title2 'HOURLY PASSAGE RATE WITHIN SONAR PERIODS';
title3 'OPTIONAL OUTPUT';
proc plot data=hprplot;
  plot perhpr*datetime=zone;
run;
**********************************************************************
* 10.9 COMPUTE SQUARED DIFFERENCES BETWEEN CONSECUTIVE HOURLY        *
*      PASSAGE RATES WITHIN EACH REPORTING PERIOD.                   *
**********************************************************************;
data varcnt1;
  set perhpr;

  * LAG DATA FOR COMPUTATION OF CONSECUTIVE SQUARED
    DIFFERENCES;
  lzone=lag(zone);
  lreport=lag(report);
  lperhpr=lag(perhpr);

  * COMPUTE SQUARED DIFFERENCES;
  if report eq lreport and zone eq lzone then
    sqdiff = (perhpr-lperhpr)**2;
  else
```

```
    sqdiff = 0;

  * DROP UNNEEDED VARIABLES;
  drop lzone lreport lperhpr;
run;
**********************************************************************
* 10.10 FOR EACH REPORT PERIOD AND ZONE, COMPUTE MEAN HOURLY PASSAGE *
*       RATE, SUM OF THE SQUARED DIFFERENCES BETWEEN CONSECUTIVE     *
*       PASSAGE RATES, NUMBER OF SONAR PERIODS, AND DEGREES OF       *
*       FREEDOM ACROSS SONAR PERIODS FOR PURPOSES OF VARIANCE        *
*       ESTIMATION.                                                  *
**********************************************************************;
proc summary data=varcnt1 nway;
  class report zone;
  id day;
  var perhpr sqdiff hoursdur;
  output out=varcnt2 mean(perhpr)=perhprmn
                     sum(sqdiff)=ssqdiff
                     n=n
                     sum(hoursdur)=sumdur;
run;
**********************************************************************
* 10.11.0 FOR EACH REPORT PERIOD AND ZONE, ESTIMATE THE VARIANCE AND *
*         CV OF THE MEAN SONAR PERIOD HOURLY PASSAGE RATE.           *
**********************************************************************;
**********************************************************************
* 10.11.1 MERGE DATA FILES.                                          *
**********************************************************************;
data varcnt2;
  merge varcnt2(drop= _type_ _freq_)
        rptdays(keep=report ndays);
  by report;
run;
**********************************************************************
* 10.11.2 REMOVE DUPLICATE ROWS CAUSED BY MERGE.                     *
**********************************************************************;
proc summary data=varcnt2 nway;
  class report day zone;
  var perhprmn ssqdiff n sumdur ndays;
  output out=varcnt2 min(perhprmn)=
                     min(ssqdiff)=
                     min(n)=
                     min(sumdur)=
                     min(ndays)=;
run;
**********************************************************************
* 10.11.3 COMPUTE VARIANCE AND CV.                                   *
**********************************************************************;
data varcnt2;
  set varcnt2(drop=_type_ _freq_);
  if n gt 1 then
    varzps=((24*ndays)**2)*(1-sumdur/(24*ndays))*(ssqdiff/(2*n*(n-1)));
  else
    varzps = 0;
  cvzps=sqrt(varzps)/(24*ndays*perhprmn);
run;
**********************************************************************
```

```
* 10.12 FOR EACH DAY AND ZONE, COMPUTE MEAN HOURLY PASSAGE RATE      *
*       ACROSS SONAR PERIODS.                                        *
**********************************************************************;
proc summary data=varcnt1 nway;
  class day zone;
  id report;
  var perhpr;
  output out=daycnt mean=perhprmn;
run;
**********************************************************************
* 10.13 SORT DATA BY REPORT PERIOD AND ZONE, AND APPLY REPORT PERIOD *
*       BASED CV ESTIMATES TO DAY-BASED HOURLY PASSAGE RATE          *
*       ESTIMATES AND COMPUTE DAILY PASSAGE ESTIMATE AND VARIANCE.   *
**********************************************************************;
proc sort data=daycnt;
  by report zone;
run;

data daycnt;
  merge daycnt (drop= _type_ _freq_)
        varcnt2(drop= day perhprmn ssqdiff n sumdur ndays);
  by report zone;
  daypass = round(24*perhprmn,1);
  vdaypass = (cvzps*daypass)**2;
  drop perhprmn varzps cvzps;
run;
**********************************************************************
**********************************************************************
**                                                                  **
** 11.0 COMBINE SONAR AND TESTFISH DATA.                            **
**                                                                  **
**********************************************************************
**********************************************************************;
**********************************************************************
* 11.1 SORT SONAR PASSAGE ESTIMATES.                                 *
**********************************************************************;
proc sort data=daycnt;
  by report zone;
run;
**********************************************************************
* 11.2 MERGE SONAR PASSAGE ESTIMATES WITH SPECIES PROPORTION         *
*      ESTIMATES.                                                    *
**********************************************************************;
data combined;
  merge daycnt rptpropw(drop=fday lday rptrcat ntfp);
  by report zone;
run;
**********************************************************************
* 11.3 TRANSPOSE DATA TO GET PROPORTIONS IN A SINGLE VARIABLE.       *
**********************************************************************;
proc sort data=combined;
  by report day zone;
run;

proc transpose data=combined out=combined name=species;
  by report day zone daypass vdaypass;
  var chinook jack schum pink fchum coho other;
```

```
run;
*********************************************************************
* 11.4 ISOLATE VARIANCE OF SPECIES PROPORTIONS.                     *
*********************************************************************;
proc summary data=spprop nway;
  class report zone species rptprop;
  var propvar;
  output out=temp min=;
run;
*********************************************************************
* 11.5 INCORPORATE ESTIMATED VARIANCE OF SPECIES PROPORTIONS.       *
*********************************************************************;
proc sort data=combined;
  by report zone species rptprop;
run;
data combined;
  merge combined temp(drop=_type_ _freq_);
  by report zone species rptprop;
  if report ge 1;

  passest = round(rptprop*daypass, 1);
  passvar = (daypass**2)*propvar + (rptprop**2)*vdaypass -
            vdaypass*propvar;
  drop vdaypass rptprop propvar;
run;
*********************************************************************
* 11.6 RECOMPUTE DAYPASS SO IT EQUALS SUM OF ROUNDED SPECIES PASSAGE *
*      ESTIMATES.                                                   *
*********************************************************************;
proc summary data=combined nway;
  class report day zone;
  var passest;
  output out=temp1 sum(passest)=daypass;
run;

proc sort data=daycnt;
  by report day zone;
run;

data daycnt;
  merge daycnt(drop = daypass) temp1(drop = _type_ _freq_);
  by report day zone;
run;

proc sort data=combined;
  by report day zone;
run;

data combined;
  merge combined(drop = daypass) temp1(drop = _type_ _freq_);
  by report day zone;
run;
*********************************************************************
* 12.0 PRINT DAILY SONAR PASSAGE ESTIMATES AND ESTIMATED STANDARD   *
*      ERRORS.                                                      *
*********************************************************************;
*********************************************************************
```

Appendix B. (Continued)

```
* 12.1 SORT DATA BY REPORT PERIOD AND DAY.                                *
**************************************************************************;
proc sort data=daycnt;
  by report day;
run;
**************************************************************************
* 12.2 TRANSPOSE PASSAGE ESTIMATES TO GET ZONE-SPECIFIC ESTIMATES        *
*      INTO SEPARATE VARIABLES.                                          *
**************************************************************************;
proc transpose data=daycnt out=daycntw1;
  by report day;
  id zone;
  var daypass;
run;
**************************************************************************
* 12.3 TRANSPOSE VARIANCE ESTIMATES TO GET ZONE-SPECIFIC ESTIMATES       *
*      INTO SEPARATE VARIABLES.                                          *
**************************************************************************;
proc transpose data=daycnt out=daycntw2;
  by report day;
  id zone;
  var vdaypass;
run;
**************************************************************************
* 12.4 COMBINE DATASETS, COMPUTE TOTAL DAILY PASSAGE AND STANDARD        *
*      ERRORS OF ALL ESTIMATES.                                          *
**************************************************************************;
data daycntw;

  * COMBINE DATASETS WITH PASSAGE AND VARIANCE ESTIMATES.
    DATASET rptdays IS NEEDED FOR PLOTTING CHARACTERS;
  merge daycntw1 (drop=_name_ rename=(_1=pass1 _2=pass2 _3=pass3))
        daycntw2 (drop=_name_ rename=(_1=var1 _2=var2 _3=var3))
        rptdays;
  by report day;

  * REPLACE MISSING VALUES WITH ZEROS.  MISSING VALUES
    SHOULD BE REMOVED BY USING OPTIONAL OUTPUT IN SECTION
    6.5 AND ESTIMATING DATA FOR MISSED PERIODS.;
  if pass1 eq . then
    pass1 = 0;
  if pass2 eq . then
    pass2 = 0;
  if pass3 eq . then
    pass3 = 0;
  if var1 eq . then
    var1 = 0;
  if var2 eq . then
    var2 = 0;
  if var3 eq . then
    var3 = 0;

  * COMPUTE TOTAL PASSAGE AND STANDARD ERRORS;
  se1 = sqrt(var1);
  se2 = sqrt(var2);
  se3 = sqrt(var3);
  total = pass1 + pass2 + pass3;
```

Appendix B. (Continued)

```
  setotal = sqrt(var1 + var2 + var3);
  if total gt 0 then
    cvtotal = setotal/total;
  else
    cvtotal = 0;

  * COMPUTE PERCENT BY BANK;
  if total > 0 then
    do;
      rightper = 100*pass1/total;
      leftper = 100-rightper;
    end;

  * FORMAT VARIABLES FOR OUTPUT;
  format pass1 pass2 pass3 total comma9.0
         se1 se2 se3 setotal 7.0
         leftper rightper 6.2
         cvtotal 5.3;
  label pass1 = 'RIGHT BANK PASSAGE'
        pass2 = 'LEFT BANK NEARSHORE PASSAGE'
        pass3 = 'LEFT BANK OFFSHORE PASSAGE'
        total = 'TOTAL PASSAGE'
        se1 = 'RIGHT BANK SE'
        se2 = 'LEFT BANK NEARSHORE SE'
        se3 = 'LEFT BANK OFFSHORE SE'
        rightper = 'PERCENT RIGHT BANK'
        leftper = 'PERCENT LEFT BANK'
        setotal = 'TOTAL PASSAGE SE'
        cvtotal = 'TOTAL PASSAGE CV';

  * DROP UNNEEDED VARIABLES;
  drop var1 var2 var3;
run;
**********************************************************************
* 12.5 PRINT PASSAGE ESTIMATES AND ESTIMATED STANDARD ERRORS.        *
**********************************************************************;
title2 'DAILY PASSAGE ESTIMATES - BY ZONE';
proc print data=daycntw noobs label;
  var report day pass1 se1 pass2 se2 pass3 se3 total setotal cvtotal
      rightper leftper;
  sum pass1 pass2 pass3 total;
run;
**********************************************************************
* 12.6 PLOT ESTIMATED DAILY TOTAL PASSAGE OVER TIME.                 *
**********************************************************************;
title2 'DAILY PASSAGE ESTIMATES';
proc chart data=daycntw;
  vbar day/sumvar=total discrete;
run;
**********************************************************************
**********************************************************************
**                                                                  **
** 13.0 PRINT AND PLOT TESTFISH CPUE VERSUS PASSAGE.                **
**                                                                  **
**********************************************************************
**********************************************************************;
**********************************************************************
```

```
* 13.1 ISOLATE TOTAL REPORT PERIOD CPUE.                                 *
************************************************************************;
proc summary data=rptcpue nway;
  class report zone;
  var rptscpue;
  output out=temp1 min(rptscpue)=rptcpue;
run;
************************************************************************
* 13.2 ISOLATE DAILY PASSAGE ESTIMATES BY ZONE.                          *
************************************************************************;
proc summary data=combined nway;
  class report day zone;
  var daypass;
  output out=temp2 min=;
run;
************************************************************************
* 13.3 SUM PASSAGE OVER DAYS WITH REPORT PERIOD, BY ZONE.                *
************************************************************************;
proc summary data=temp2 nway;
  class report zone;
  var day daypass;
  output out=temp2 min(day)=
                   sum(daypass)=rptpass;
run;
************************************************************************
* 13.4 MERGE REPORT PERIOD TESTFISH CPUE AND PASSAGE SUMS.               *
************************************************************************;
data cpuepass;
  merge temp1(drop=_type_ _freq_) temp2(drop=_type_ _freq_);
  by report zone;
run;
************************************************************************
* 13.5 SORT FILE BY DAY.                                                 *
************************************************************************;
proc sort data=cpuepass;
  by day;
run;
************************************************************************
* 13.6 ADD PLOTTING CHARACTERS TO DATA AND PREPARE DATA FOR              *
*      PRINTING.                                                         *
************************************************************************;
data cpuepass;
  merge cpuepass(in=a) rptdays(keep=report day plotchar);
  by day;
  if rptcpue ne .;

  label report = 'REPORT PERIOD'
        day = 'DAY PERIOD BEGAN'
        plotchar = 'PLOTTING CHARACTER'
        rptcpue = 'TOTAL PERIOD CPUE'
        rptpass = 'TOTAL PERIOD PASSAGE';

  format rptcpue 8.2 day date7. rptpass comma9.;
run;
************************************************************************
* 13.7 PRINT REPORT PERIOD CPUE AND PASSAGE ESTIMATES.                   *
************************************************************************;
```

```
title2 'COMPARISON OF PASSAGE ESTIMATES AND TESTFISH CPUE';
title3 'BY REPORT PERIOD AND ZONE';
 proc print data=cpuepass label;
  var report day zone plotchar rptcpue rptpass;
  sum rptcpue rptpass;
run;
**********************************************************************
* 13.8 PLOT PASSAGE ESTIMATES VERSUS TESTFISH CPUE BY ZONE.          *
**********************************************************************;
proc sort data=cpuepass;
  by zone;
run;

proc plot data=cpuepass;
  plot rptcpue*rptpass=plotchar;
  by zone;
run;
**********************************************************************
**********************************************************************
**                                                                  **
** 14.0 COMPUTE AND PRINT PASSAGE ESTIMATES BY DAY AND SPECIES.     **
**                                                                  **
**********************************************************************
**********************************************************************;
**********************************************************************
* 14.1 RETRIEVE NEEDED VARIABLES.                                    *
**********************************************************************;
data final;
  set combined (keep= report day zone species passest passvar);
run;
**********************************************************************
* 14.2 SUM ESTIMATES ACROSS ZONES.                                   *
**********************************************************************;
proc summary data=final nway;
  class report day species;
  var passest passvar;
  output out=final sum(passest)=total
                   sum(passvar)=vartotal;
run;
**********************************************************************
* 14.3 TRANSPOSE DAILY SPECIES PASSAGE ESTIMATES TO GET A SEPARATE   *
*      COLUMN FOR EACH SPECIES.                                      *
**********************************************************************;
proc transpose data=final out=finalw;
  by report day;
  id species;
  var total;
run;
**********************************************************************
* 14.4 SUM PASSAGE ESTIMATES OVER SPECIES.                           *
**********************************************************************;
proc summary data=final nway;
  by report day;
  var total;
  output out=temp sum(total)=allspp;
run;
**********************************************************************
```

```
* 14.5 COMBINE SPECIES AND TOTAL ESTIMATES, AND COMPUTE TOTAL SALMON *
*      AND TOTAL NON-SALMON ESTIMATES.                               *
*********************************************************************;
data finalw;
  merge finalw(drop=_name_) temp(drop= _type_ _freq_);
  by report day;

  * FORMAT VARIABLES FOR OUTPUT;
  format chinook jack coho other comma7.
         schum fchum pink allspp comma9.;
  label chinook = 'LARGE CHINOOK'
        jack = 'SMALL CHINOOK'
        schum = 'SUMMER CHUM'
        fchum = 'FALL CHUM'
        other = 'NON SALMON'
        allspp = 'TOTAL ALL SPECIES';
run;
*********************************************************************
* 14.6 PRINT DAILY PASSAGE ESTIMATES BY SPECIES.                     *
*********************************************************************;
title2 'ESTIMATED DAILY PASSAGE - BY SPECIES';
proc print data=finalw noobs label;
  var report day;
  sum chinook jack schum pink fchum coho other allspp;
run;
*********************************************************************
*********************************************************************
**                                                                 **
** 15.0 COMPUTE CUMULATIVE PASSAGE TO DATE, BY SPECIES, WITH       **
**      CONFIDENCE INTERVALS.                                      **
**                                                                 **
*********************************************************************
*********************************************************************;
*********************************************************************
* 15.1 ISOLATE PASSAGE FROM LAST DAY.                                *
*********************************************************************;
data temp;
  set combined (keep = day zone species passest);
  _type_ = 0;
run;

data temp;
  merge temp maxsday;
  by _type_;
  if day eq maxsday;
  drop _type_ _freq_ day maxsday;
run;


proc sort data=temp;
  by species;
run;


proc transpose data=temp out=temp;
  by species;
  var passest;
```

```
run;

data temp;
  set temp(drop = _name_);
  rename col1=zone1;
  rename col2=zone2;
  rename col3=zone3;
run;
**********************************************************************
* 15.2 SUM PASSAGE ESTIMATES BY SPECIES OVER ALL DAYS.               *
**********************************************************************;
proc summary data=final nway;
  class species;
  var day total vartotal;
  output out=final max(day)=
                   sum(total)=
                   sum(vartotal)=;
run;
**********************************************************************
* 15.3 COMBINE TOTALS WITH ESTIMATES FOR THE MOST RECENT DAY.        *
**********************************************************************;
data final;
  merge final temp;
  by species;
run;
**********************************************************************
* 15.4 COMPUTE STANDARD ERRORS AND CONFIDENCE LIMITS.                *
**********************************************************************;
data final;
  set final (drop= _type_ _freq_);

  * COMPUTE STANDARDS ERRORS AND CV'S;
  setotal = sqrt(vartotal);
  if total gt 0 then
    cvtotal = setotal/total;
  else
    cvtotal = 0;

  * COMPUTE CONFIDENCE LIMITS;
  lower = total - 1.645*setotal;
  if lower lt 0 then
    lower = 0;
  upper = total + 1.645*setotal;

  * COMPUTE DAILY TOTAL;
  daytotal = zone1 + zone2 + zone3;

  * FORMAT VARIABLES FOR OUTPUT;
  format total setotal lower upper zone1 zone2 zone3 daytotal comma9.
         cvtotal 5.3;
  label total = 'ESTIMATED PASSAGE TO DATE'
        setotal = 'ESTIMATED STANDARD ERROR'
        cvtotal = 'COEFFICIENT OF VARIATION'
        lower = 'LOWER LIMIT 90% CI'
        upper = 'UPPER LIMIT 90% CI'
        zone1 = 'RIGHT BANK DAILY'
        zone2 = 'LEFT BANK NEARSHORE DAILY'
```

```
        zone3 = 'LEFT BANK OFFSHORE DAILY'
        daytotal = 'DAILY TOTAL';

  * DEFINE VARIABLE TO CONTROL PRINT ORDER IN FOLLOWING
    PRINT;
  if species eq 'CHINOOK' then
      order = 1;
  else if species eq 'JACK' then
    order = 2;
  else if species eq 'SCHUM' then
    order = 3;
  else if species eq 'FCHUM' then
    order = 4;
  else if species eq 'COHO' then
    order = 5;
  else if species eq 'PINK' then
    order = 6;
  else
    order = 7;
run;
**********************************************************************
* 15.5 SORT PASSAGE ESTIMATES AND PRINT.                             *
**********************************************************************;
proc sort data=final;
  by order;
run;

title2 'DAILY AND CUMULATIVE ESTIMATED PASSAGE TO DATE - BY SPECIES';
title3 'WITH MEASURES OF PRECISION FOR CUMULATIVE ESTIMATES';
proc print data=final label;
  label species = 'SPECIES';
  var day species zone1 zone2 zone3 daytotal total setotal cvtotal
      lower upper;
  sum zone1 zone2 zone3 daytotal total;
run;
**********************************************************************
**********************************************************************
**                                                                  **
** 16.0 PROCESS 24 HOUR SONAR DATA.                                 **
**                                                                  **
**********************************************************************
**********************************************************************;
**********************************************************************
* 16.1 SUM UPSTREAM COUNTS ACROSS SECTORS.                           *
**********************************************************************;
proc summary data=sonar24 nway;
  class day speriod stratum starttime;
  id zone counthrs;
  var upcount;
  output out=sonar24 sum=;
run;
**********************************************************************
* 16.2 SUM UPSTREAM COUNTS AND COUNTING TIME ACROSS ALL SAMPLE TIMES *
*      WITHIN EACH STRATA.                                           *
**********************************************************************;
proc summary data=sonar24 nway;
  class day stratum;
```

Appendix B. (Continued)

```
  id zone;
  var upcount counthrs;
  output out=sonar24 sum(upcount)=
                     sum(counthrs)=;
run;
*********************************************************************
* 16.3 ESTIMATE DAILY PASSAGE RATE WITHIN EACH STRATA.              *
*********************************************************************;
data sonar24;
  set sonar24(drop=_type_ _freq_);
  passage = 24*upcount/counthrs;
run;
*********************************************************************
* 16.4 ESTIMATE DAILY PASSAGE BY DAY AND BANK.                      *
*********************************************************************;
proc summary data=sonar24 nway;
  class day zone;
  var passage;
  output out=sonar24 sum=;
run;
*********************************************************************
* 16.5 TRANSPOSE DATA.                                              *
*********************************************************************;
proc transpose data=sonar24 out=sonar24w;
  var passage;
  id zone;
  by day;
run;
*********************************************************************
* 16.6 PREPARE DATA FOR OUTPUT.                                     *
*********************************************************************;
data sonar24w;
  set sonar24w (drop=_name_);
  total = _1 + _2 + _3;
  format _1 _2 _3 total comma10.0;
  label _1 = 'RIGHT BANK PASSAGE'
        _2 = 'LEFT BANK NEARSHORE PASSAGE'
        _3 = 'LEFT BANK OFFSHORE PASSAGE'
        total = 'TOTAL PASSAGE';
run;
*********************************************************************
* 16.7 PRINT 24 HOUR PASSAGE ESTIMATES.                             *
*********************************************************************;
title2 'DAILY PASSAGE ESTIMATES - BY ZONE';
title3 'FOR 24-HOUR COUNT DAYS';
proc print data=sonar24w label noobs;
  var day _1 _2 _3 total;
run;
```

Appendix C. Yukon River sonar hourly passage rate by stratum, 1997.

REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE
1	6/6	1	56.3	.	.	
1	6/6	2	64.1	.	.	
1	6/6	3	57.2	.	55.1	2.4
1	6/7	1	65	.	70.5	1.4
1	6/7	2	78	.	51.5	5.2
1	6/7	3	42.5	.	102.2	9.3
2	6/8	1	66.4	.	104.3	8
2	6/8	2	70.4	.	125.7	9.3
2	6/8	3	68.1	.	87	9.3
3	6/9	1	56	.	129.3	11.7
3	6/9	2	74.3	.	93.4	6.7
3	6/9	3	48.3	.	93.6	4.8
4	6/10	1	66.7	.	99.7	6
4	6/10	2	70.7	.	187.7	12.3
4	6/10	3	115.3	124.8	285.6	2.4
5	6/11	1	276	321.5	1071.7	40
5	6/11	2	589	847.8	2030.9	81.8
5	6/11	3	700	913.2	1994.2	124.3
6	6/12	1	925.7	1057.4	1812.2	122.1
6	6/12	2	748.5	836	1357.3	94
6	6/12	3	580.6	351.9	1369.1	94.8
7	6/13	1	641.7	758.9	1197.9	85.4
7	6/13	2	427.1	720	743.6	54.5
7	6/13	3	318.4	549.2	812.6	57.6
8	6/14	1	380.3	985	908.3	37.2
8	6/14	2	352	489.8	733.9	55.6
8	6/14	3	277.3	488.4	552.4	43.9
9	6/15	1	259.3	364.1	445.3	38.2
9	6/15	2	174.3	244.7	292.4	37.5
9	6/15	3	171.3	78.1	243.5	24.5
9	6/16	1	164	114	249	53.7
9	6/16	2	242	370.2	846.3	85.6
9	6/16	3	359.6	374.7	920.7	53.5
10	6/17	1	483	604.1	762	73
10	6/17	2	340.7	380.7	515	58.4
10	6/17	3	297	307.9	434.2	53.5
11	6/18	1	342.5	370	495	28.2
11	6/18	2	280.7	231.9	387.9	28.4
11	6/18	3	272.7	152.5	262.2	47.7
11	6/19	1	371.9	361	465.8	93
11	6/19	2	611.1	947	1255.9	110.5
11	6/19	3	948	1399.1	1586.7	136.7
12	6/20	1	2462.3	3658	2687.3	273.9

MISSING RANGES:
Estimated data*
Unestimated data

Using LBOS only, 0-80 m (0-30 m of LBNS + 50 m of noise-blocked signal)

* Data was estimated from periods sampled on the same day.

-Continued-

REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE	MISSING RANGES: Estimated data* / Unestimated data
12	6/20	2	2119.3	2962.2	3658.6	274.3	
12	6/20	3	1832.4	2038	3354.7	342.3	
13	6/21	1	2264	2603.6	2785.7		250-302 m
13	6/21	2	1289.3	1538.9	1383.5		
13	6/21	3	902.3	1187.6	1270.2	60	
14	6/22	1	1158.9	1388.2	879.3		S5 250-302 m
14	6/22	2	949.2	736.2	536.9		
14	6/22	3	908.3				All LB
14	6/23	1	554.3				
14	6/23	2	921.7	1006.3	1349	42.4	
14	6/23	3	2238.4				All LB
15	6/24	1	2790.3				S5 250-300 m
15	6/24	2	2097.3				
15	6/24	3	1849	2560	1109.3		
16	6/25	1	1584.7	860	620		
16	6/25	2	1051.3				
16	6/25	3	783.3				
17	6/26	1	705.3				All LB
17	6/26	2	754.5				
17	6/26	3	1590.3				
18	6/27	1	1197.3				
18	6/27	2	893.3		1047.7		0-50 m & 250-302 m
18	6/27	3	869.1		1015.1		
18	6/28	1	1031.7		767.5		
0	6/28	2					
0	6/28	3					
0	6/29	1					All LB & all RB
0	6/29	2					(No data obtained)
0	6/29	3					
0	6/30	1					
0	6/30	2					
0	6/30	3					
0	7/1	1					
20	7/1	2	841				All LB
0	7/1	3					All LB & all RB
21	7/2	1	692.1				All LB
0	7/2	2					All LB & all RB
21	7/2	3	637.7				All LB
22	7/3	1	508.9				
22	7/3	2	333.6				
22	7/3	3	458				
22	7/4	1	322.9		137	1.9	0-50 m

*Data was estimated from periods sampled on the same day.

-Continued-

MISSING RANGES: Estimated data* / Unestimated data

REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE	MISSING RANGES
22	7/4	2	450.8		116.4	4.8	
22	7/4	3	402.3		122.9	6.3	
23	7/5	1	421.6		170.1	9.6	
23	7/5	2	440.2		258	13.4	
23	7/5	3	744.1		257.7	10	
24	7/6	1	569.5		302.7	4	
24	7/6	2	588.3	30	288.6	6.9	
24	7/6	3	639.1	188.1	774.5	19.6	
25	7/7	1	778.6	212.3	479.5	14.7	
25	7/7	2	845.6	169.1	718	9.5	
25	7/7	3	728.2	373.8	1010.4	12.9	
26	7/8	1	722.7	283.5	690.5	13.2	
26	7/8	2	1052	260.2	806.7	16.8	
26	7/8	3	965.4	278.5	564.6	4.1	
27	7/9	1	980.3	381.4	502.4	3.8	
27	7/9	2	848.7	1122.4	442.9	17.6	
27	7/9	3	673.4	1181.4	501.7	12	
28	7/10	1	619.3	1291	712	27	
28	7/10	2	649	775.1	395.7		250-350 m
28	7/10	3	520	738.6	421.1	20.8	
29	7/11	1	403.7	529.3	458.6	16.2	
29	7/11	2	296.6	636.6	302.5	23.8	
29	7/11	3	304.7	715.9	343.4	26.8	
29	7/12	1	338	550.2	396.6	10.5	
29	7/12	2	361.7	593.6	403	15.6	
29	7/12	3	379.8	464.4	256.1	14.1	
30	7/13	1	319.7	578.8	287.4	13.7	
30	7/13	2	278.7	670	470.7	35.4	
30	7/13	3	347.3	677.1	376.6	11.2	
31	7/14	1	271.7	663.2	410	33	
31	7/14	2	261.7	486.4	343.9	17.9	
31	7/14	3	186.5	532.3	256.6	8.3	
32	7/15	1	142	451	331.5	14	
32	7/15	2	164.6	417	270.5	36.7	
32	7/15	3	119.7	464.5	265.7	6.3	
33	7/16	1	117.6	405	177.9	8.7	
33	7/16	2	145.3	349.8	181.1	17.1	
33	7/16	3	85.2	332.1	168.8	5.7	
34	7/17	1	100	317.9	146.9	5.7	
34	7/17	2	94.9	350.8	171.7	7.4	
34	7/17	3	127.7	366	192.4	18	
35	7/18	1	123.4	406	262.4	19.7	

*Data was estimated from periods sampled on the same day.

-Continued-

REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE	MISSING RANGES: Estimated data* Unestimated data
35	7/18	2	82	318.3	191.3	7.5	
35	7/18	3	116.7	245.1	110.7	9.3	
36	7/19	1	95.3	255.5	167.1	14.2	
36	7/19	2	86	278.2	182.1	18.4	
36	7/19	3	64.4	290.9	140.7	21.7	
36	7/20	1	89	228.8	121.1	4.7	
36	7/20	2	66.7	304	243.2	18.5	
36	7/20	3	117.3	301	154.7	7.6	
37	7/21	1	110	262.1	139.7	5.2	
37	7/21	2	76.3	240	84.8	10	
37	7/21	3	104.7	246.1	120	15	
38	7/22	1	96.7	300.7	99.3	12.4	
38	7/22	2	131	364	197.6	16.1	
38	7/22	3	124.7	264.4	94.7	7.5	
39	7/23	1	89.5	407.8	217.2	28.5	
39	7/23	2	63	559.7	247.7	15	
39	7/23	3	130	456.6	165.3	7.5	
40	7/24	1	93	396.2	151.9	35.2	
40	7/24	2	92	480	114.8	29	
40	7/24	3	108	530.5	179	41.8	
41	7/25	1	94.7	554.1	160	22.9	
41	7/25	2	144	445.9	162.5	17.5	
41	7/25	3	101.5	499.7	148.9	27	
42	7/26	1	102.1	485.8	168	22.9	
42	7/26	2	137.3	738.3	251.4	35.8	
42	7/26	3	173.9	764.7	369.6	41.4	
43	7/27	1	284.6	1033.2	541	45.5	
43	7/27	2	265	1765.3	901.1	66.9	
43	7/27	3	423.3	1301.9	757.3	75.4	
44	7/28	1	302	963.5	517.9	49.5	
44	7/28	2	243.1	983.4	595.9	53.7	
44	7/28	3	231.7	774.8	523.1	34.4	
45	7/29	1	257.6	733.4	372.4	28.4	
45	7/29	2	235.8	823	288	22.6	
45	7/29	3	256.1	696.2	293.5	20.7	
46	7/30	1	129.7	730.2	324.4	17.1	
46	7/30	2	151	795	356.8	40	
46	7/30	3	232	388	155.8	24.5	
47	7/31	1	159.3	332.4	112.8	16	
47	7/31	2	110.4	356.9	123.1	7.2	
47	7/31	3	117	207.9	84.6	13.5	
47	8/1	1	96	216.6	97.2	25.3	

*Data was estimated from periods sampled on the same day.

-Continued-

REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE	MISSING RANGES. Estimated data* / Unestimated data
47	8/1	2	138.7	203.8	62.1	4.4	
47	8/1	3	85.3	211.6	109.5	24.6	
48	8/2	1	90	242.1	132.4	14.5	
48	8/2	2	141.7	366.5	229.5	30.6	
48	8/2	3	131.3	177.9	103.2	13.1	
49	8/3	1	136.5	195.3	144.2	23.4	
49	8/3	2	73.8	387	322.8	30	
49	8/3	3	115.4	296.5	215.8	43.6	
50	8/4	1	110.9	218.6	177.9	13.1	
50	8/4	2	76.3	162.4	77.5	16.6	
50	8/4	3	69.3	135.5	87.3	5.3	
51	8/5	1	158.3	214.4	132.9	6.5	
51	8/5	2	317.7	546.1	258.9	20	
51	8/5	3	568	1146.1	235.8	31.8	
52	8/6	1	600.7	1437.3	457.2	51.3	
52	8/6	2	560	1878	408.8	55.7	
52	8/6	3	653.3	2125.9	409.3	51.8	
53	8/7	1	482.7	1438.8	182.1	43.2	
53	8/7	2	378.3	1163.4	214.1	21.4	
53	8/7	3	383	673.9	234.6	16	
54	8/8	1	257.3	648.8	167.8	19.7	
54	8/8	2	166	502.2	256.8	40	
54	8/8	3	157.8	402.9	146.4	7.1	
54	8/9	1	177.6	321.4	71.6	3.8	
54	8/9	2	152.3	329.4	76.6	4.6	
54	8/9	3	112.7	325.3	57.9	8	
55	8/10	1	121	291.9	55.9	6.9	
55	8/10	2	117	363	89	8.7	
55	8/10	3	106.6	214.5	35.8	3.1	
56	8/11	1	123.7	154.4	24.3	1.1	
56	8/11	2	96.3	166.7	33.8	0	
56	8/11	3	73.2	184	29.5		250-332 m
57	8/12	1	116	242	51.7	0	
57	8/12	2	96	319.1	136.8	55.4	
57	8/12	3	171.2	246.9	87.3	20.4	
58	8/13	1	196.5	258.5	92.6	82.4	
58	8/13	2	191.8	248.3	108.6	80	
58	8/13	3	212.5	405.7	167.6	77.7	
59	8/14	1	383.3	550.2	209	71.4	
59	8/14	2	406.3	1043.4	231.6	62.2	
59	8/14	3	601.3	972.4	248.6	73.3	
59	8/15	1	517.7	662	160.3	84.2	

*Data was estimated from periods sampled on the same day.

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REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE	MISSING RANGES: Estimated data* / Unestimated data
59	8/15	2	466.4	411.9	193.6	76.4	
59	8/15	3	363	452.1	157.5	76.4	
60	8/16	1	375	407.4	205.1	68.4	
60	8/16	2	295.2	780	387.3	104.7	
60	8/16	3	325.8	687.9	320.4	83.3	
61	8/17	1	264.3	586.6	306.2		136-336 m
61	8/17	2	306	618.3	292.8	187.1	
61	8/17	3	320.7	520.7	285.8	80	
62	8/18	1	276.3	650.8	367.2		136-336 m
62	8/18	2	234	226	223.2	182.6	
62	8/18	3	234.6	438.2	347.1	120	
63	8/19	1	291.9	668.4	553.4	180	
63	8/19	2	252.6	750	363.4	116.4	
63	8/19	3	238.7	546.5	432.9	132.4	
64	8/20	1	303.3	511.2	396.8	110	
64	8/20	2	221	545.1	563.6	58.4	
64	8/20	3	214.7	407.1	261.8	40.5	
65	8/21	1	237	330	228.2	23.3	
65	8/21	2	152.3	308.1	302.5	40	
65	8/21	3	142	223.5	216.2	63.5	
66	8/22	1	157	167.8	176.8	45.3	
66	8/22	2	191.5	165	172.5	19.3	
66	8/22	3	113	194.2	185.6	66.3	
67	8/23	1	127.4	139	87.9	16.1	
67	8/23	2	124	197.8	207.4	45.3	
67	8/23	3	111.7	125.3	102.1	26.8	
68	8/24	1	126.7	142	90.5	21.4	
68	8/24	2	112.7	147.5	131.8	32.9	
68	8/24	3	99.3	148.5	161.4	28.8	
69	8/25	1	125.7	153.2	104.2	35.1	
69	8/25	2	112.9	154.6	142.4	38.9	
69	8/25	3	136.7	197.6	115.6	15.8	
70	8/26	1	185.3	287	168.7	22	
70	8/26	2	148.7	333.6	223.4	52.8	
70	8/26	3	140.7	290.5	136.3	37.1	
71	8/27	1	183.3	331.5	179	44	
71	8/27	2	152.2	428.3	209.5	31	
71	8/27	3	166.7	168.8	144	20.7	
72	8/28	1	160	265.3	174.4	12	
72	8/28	2	107.3	260.7	213.1	32.6	
72	8/28	3	177.7	258.6	157.1	24.9	
73	8/29	1	159.8	390.5	317.6	311.4	

*Data was estimated from periods sampled on the same day.

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REPORT PERIOD	DATE	SONAR PERIOD	STRATUM 1 RIGHT BANK	STRATUM 3 LEFT BANK NEARSHOR	STRATUM 4 LEFT BANK MIDSHORE	STRATUM 5 LEFT BANK OFFSHORE	MISSING RANGES: Estimated data* Unestimated data
73	8/29	2	154.5	332.1	120	44.4	
73	8/29	3	104.3	282.4	150.5	25.7	
74	8/30	1	120.3	348	151	16.4	
74	8/30	2		228.4	358.9	188.6	RB 0-120 m
74	8/30	3	121.2	87.9	113.7	41.8	
75	8/31	1	150.3	117.9	201.1	51.2	
75	8/31	2	101.7	138	139.7	76.5	
75	8/31	3	105.7	102.7	159.6	71.3	

*Data was estimated from periods sampled on the same day.

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